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Observations on an Epidemic of Cerebrospinal Meningitis in Cyprus and the Record of a Prophylactic Experiment

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ABSTRACT.—After a lapse of twenty-five years cerebrospinal meningitis appeared again in epidemic form during 1936-37.

A prophylactic inoculation experiment was undertaken during the autumn of 1937, a few months before the second epidemic season was due to begin.

Season 1936-37—836 cases—284 deaths.

Season 1937-38 (after inoculation)—298 cases—81 deaths.

Season 1938-39—122 cases—51 deaths (to end of May, 1939).

During the second season conditions were suitable for the continuance of the epidemic. We do not think that we obtained a false result by inoculating on a waning epidemic. Our results are inconclusive because owing to the sharp decline in the morbidity neither control nor inoculated groups were fully at risk. But our results are good enough to recommend a further trial of prophylaxis in future epidemics. The percentage of the population inoculated is an important factor. The aim should be 100%.

The experiment should aim at controlling not only the meningococcal carrier rate but also the general catarrh rate. We suggest that the rapid passage of the meningoccocus in association with an epidemic of nasopharyngeal catarrh raises the virulence of the meningococcus.

As the opportunity of a second experience in the prevention of cerebrospinal meningitis by prophylactic inoculation seldom occurs to an individual, we take this chance of making recommendations for guiding future experiments.

RÉSUMÉ.—Après un intervalle de 25 ans la méningite cérébrospinale a reparu en Chypre en forme d'épidémie en 1936-37.

Un essai d'inoculation prophylactique a été fait en automne 1937, quelques mois avant la date attendue du commencement de la seconde saison de l'épidémie.

Saison 1936-37—836 cas—284 morts.

Saison 1937-38 (après inoculation)—298 cas—81 morts.

Saison 1938-39 —122 cas—51 morts (jusqu'à la fin de mai, 1939).

Pendant la deuxième saison les conditions étaient favorables pour l'épidémie. Nous ne croyons pas avoir obtenu de faun résultats en inoculant pendant une épidémie décroissante. Nos résultats ne sont pas décisifs parce que, en vue de la diminution brusque de la morbidité, ni le groupe vacciné ni les contrôles étaient exposés à tout le risque d'infection. Toutefois les résultats sont assez bons pour justifier la prophylaxie pendant des épidémies futures.

La proportion de la population soumise à la vaccination est importante; le but doit être 100%.

L'experience doit chercher à contrôler non seulement la proportion de porteurs de méningocoques, mais aussi la proportion de catarrhes généraux.

Nous suggérons que le passage rapide des méningocoques associé à une épidémie de catarrhe naso-pharyngien augmente la virulence des méningocoques.

Comme un individu n'a que rarement l'opportunité de prévenir une seconde épidémie de méningite cérébrospinale par l'inoculation prophylactique, nous profitons de cette occasion pour faire quelques recommandations pour guider les expériences futures.

ZUSAMMENFASSUNG.—Nach einer Zwischenzeit von 25 Jahren trat die Meningitis cerebrospinalis in Cypern im Jahre 1936-37 wieder als Epidemie auf.

Ein Versuch mit prophylaktischer Impfung wurde im Herbst 1937 unternommen, einige Monate vor dem erwarteten Beginn der zweiten Welle der Epidemie.

Saison 1936-37—836 Fälle—284 Todesfälle.

Saison 1937-38 (nach Impfung)—298 Fälle—81 Todesfälle.

Saison 1938-39—122 Fälle—51 Todesfälle (bis Ende Mai).

Während dem zweiten Saison waren die Verhältnisse für das Fortbestehen der Epidemie günstig. Wir glauben nicht dass wir durch Impfung während einer abklingenden Epidemie zu falschen Ergebnissen gekommen sind. Die Ergebnisse sind wegen der raschen Abnahme der Morbidität nicht entscheidend, da weder die Geimpften noch die Kontrollgruppe dem vollen Risiko ausgesetzt waren. Immerhin sind sie so gut dass prophylaktische Impfung bei zukünftigen Epidemien zu empfehlen ist.

Der Prozentsatz der geimpften Bevölkerung ist ein wichtiger Faktor. Das Ziel müsste 100% sein.

Der Versuch sollte auf die Kontrolle nicht nur des Meningokokkenträger Verhältnisses, sondern auch des gewöhnlichen Katarrh Verhältnisses zielen.

Wir weisen darauf hin, dass die rasche Passage von Meningokokken während einer Epidemie von Nasen-Rachen Katarrh die Virulenz der Meningokokken steigert.

Da nur sehr wenig Beobachter Gelegenheit haben einen zweiten Versuch der prophylaktischen Impfung gegen Meningitis cerebro-spinalis zu unternehmen, benutzen Verff. diese Gelegenheit um Richtlinien zur Durchführung weiterer Untersuchungen zu geben.
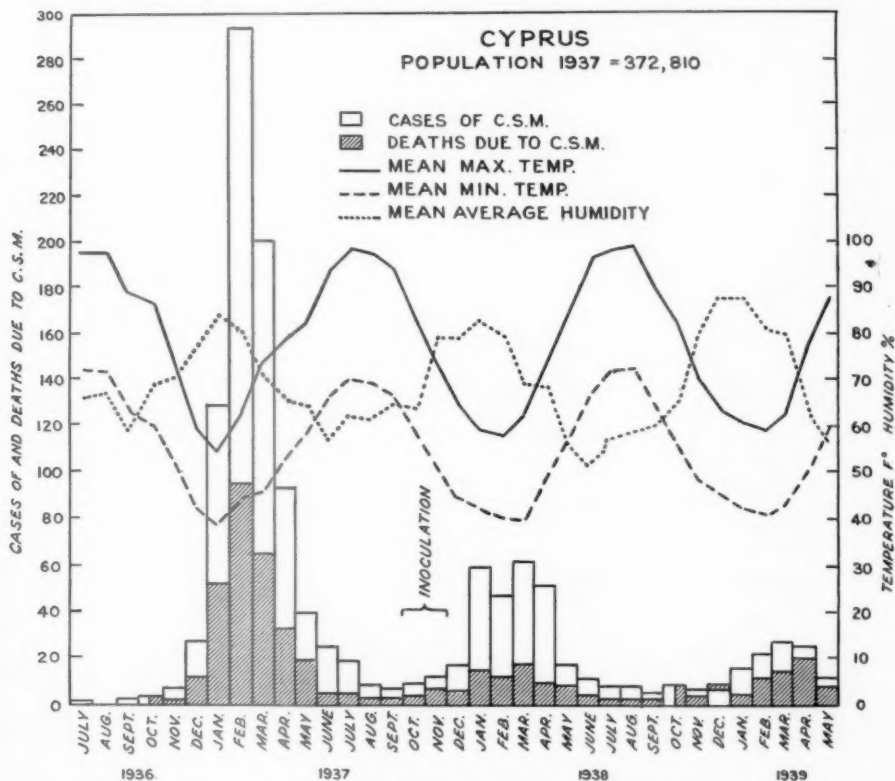
CEREBROSPINAL MENINGITIS IN CYPRUS

THE history of cerebrospinal meningitis in Cyprus has recently been reviewed by Neff and Markides (1937). From this survey it appears that the first recorded outbreak of the disease occurred in the winter of 1887 to 1888, when over 400 cases were reported. At this time all health records seem to have been very incomplete, and it is probable that these figures by no means represent the total number of cases that occurred. From 1888 to 1908 only an occasional case of this disease is recorded, but in the spring of that year 140 cases with 96 deaths are recorded. In the following winter there were 1,153 cases with 600 deaths ; in the next season 1,080 cases with 546 deaths. In the fourth season 84 cases are mentioned but there is no record of the number of deaths. Details of these epidemics are scanty, but in the 1908–09 wave it is stated that 55% of cases were under 20 years of age and 30% in the 10–20 age-group. The epidemic waves occurred in the winter, with the maximum incidence in February and March.

Since 1910 cases of cerebrospinal meningitis have occurred sporadically with an occasional slight increase in incidence. Thus, there were 25 cases reported in 1913, 48 in 1918, and 27 in 1921. 1935 was the only year since 1908 in which no cases were reported ; but in July and September 1936 isolated cases were reported from different districts. The September case was followed within a week by a case in a miner employed by the Cyprus Mines Corporation who had come from the same district. At the mines conditions commonly thought to predispose to an epidemic of cerebrospinal meningitis were all present, viz. overcrowding, fatigue, dust, excessive alcohol consumption, prevalence of nasopharyngeal catarrhs, and a constant supply of new recruits.

From the mines the disease spread to the neighbouring villages so that in December 1936, 26 cases were reported. The incidence reached its peak in February 1937 when 288 cases were notified. As the weather became warmer, the epidemic gradually subsided so that only seven cases were notified in August, and six in September. The number of cases and deaths and the meteorological conditions observed in Cyprus, are correlated in Graph I; that the greatest number of cases occurs when the maximum temperature in degrees Fahrenheit has fallen to below the relative

humidity at 2 p.m. expressed as a percentage; and that the incidence of the disease lags roughly one month behind the changes in the meteorological observations. The cold, wet weather, not only accentuates the overcrowding, but also increases nasopharyngeal catarrh. During the winter of 1936–37 there was a widespread epidemic of mild influenza, associated with considerable catarrhal symptoms but without many serious complications. The influence of climatic conditions in Cyprus therefore appears to be the direct opposite to that observed

GRAPH I.—Progress of cerebrospinal meningitis in Cyprus (1936-39) correlated with the meteorological conditions and the inoculation experiment.

in the Sudan, where the dry, dusty weather is associated with catarrh and cerebrospinal meningitis.

The distribution of cases during the twelve months from October 1, 1936, is shown in Maps 1 and 3 (*see* pp. 1569 and 1571), where it can be seen that the disease is concentrated near the main roads leading from the mines. The coastal region immediately west of the mining area (Tyllaria area) was more particularly affected. It should be noted that this area is one of the worst malarious regions in the island; and on the average the houses are smaller and more crowded than in other parts of Cyprus. We have gained the impression that malaria has had some influence on the distribution of cerebrospinal meningitis, though it is difficult to obtain any

direct evidence.   Contact with the mines is unquestionably the most important factor, but it seems that in the case of places with equal contact, those villages with a high malaria incidence had a higher incidence of cerebrospinal meningitis compared with those with little or no malaria.   Paphos district and the Tyllaria area have the highest spleen rates and also the greatest incidence of cerebrospinal meningitis.   Individual villages that had particularly high incidence were nearly always malarious.

70% of the cases occurred in those under 30 years of age, 41% in those under 10. The disease was less severe clinically than that usually experienced in Great Britain.

Following the first wave, and before the expected second wave of the epidemic, it was decided to try the use of a prophylactic vaccine on a large scale.

Previous Prophylactic Vaccination

The first attempt at prophylactic vaccination against cerebrospinal meningitis was done by Davis (1907) who had to give up this work because his large doses caused severe reactions—in some cases amounting to meningism.   Sophian and Black (1912), using doses of 500, 1,000 and 2,000 million organisms at weekly intervals, got better results, and established that their vaccine gave an immune response comparable with that found in convalescents.   Kolmer and Rule (1938) working with guinea-pigs, rabbits and monkeys, showed that active vaccination protected these animals against infecting doses of meningococci which were capable of killing or (in the case of monkeys) causing the disease, in all their control animals.

Greenwood (1916) and Gates (1918) reported in favour of prophylactic inoculation but gave no control results.   Bruynoghe and Walwarrens (1930), Le Bourdelles and Sedallian (1930), Saleun and Ceccaldi (1936), Yacob (1935), Russell (1936), Zrůnek and Feierabend (1931), Sorel (1937), all reported a lower case incidence among their inoculated than among the control groups.   The above worked during epidemic periods, and yet all considered that that their inoculation had had a favourable effect on the course of the epidemic.   Zrůnek and Feierabend also inoculated out of epidemic times certain garrisons which had a bad history for cerebrospinal meningitis during previous seasons.   Although the incidence of the disease was as great among the inoculated as among the control non-inoculated, they concluded that the garrisons where at least 50% of the men had been inoculated fared very much better than did garrisons where no inoculation had taken place.   This change for the good in the inoculated garrisons occurred in spite of an alteration of personnel and the arrival of many new recruits.   The benefits cannot therefore be attributed to any increased immunity of the population due to salting.   For example, in 1926 there were 31 cases in the selected garrisons whereas after inoculation in 1927 there were only 10.   On the other hand in a similar group of garrisons where no inoculations had taken place the ratio of cases in the same two years was as 21 to 16, showing that the incidence of the disease was greatly reduced in the inoculated garrisons but had persisted in the others.   These numbers are small and they can only be considered as a pointer of the way prophylactic inoculation works in this disease.

Riding and Corkill (1932) report a failure for prophylactic inoculation. They compared the number of cases occurring in Group A (meningococcal vaccine) with a similar Group B (TAB vaccine).   Both groups had an almost equal incidence, but the control group should have been all the uninoculated in the district.   They inoculated in Deims at the peak of the epidemic, and they allowed only one day for the immunity from the vaccine to develop.   They do not say how many cases occurred in this place within the next four days, which most immunologists would have considered the shortest period in which immune bodies could have developed after vaccination. In Khartoum city, where they inoculated before the peak of the epidemic, their results were much better, viz.:

Inoculated Group A (meningococcal vaccine)	2,584	No cases
Inoculated Group B (TAB vaccine) ..	2,807	5 cases
Uninoculated (rest of population) ..	4,809	22 cases

Read this way, their results are in favour of meningococcal prophylactic inoculation in epidemic cerebrospinal meningitis.

There are thus two ways of reading results : (1) Lowered case-rate in inoculated and uninoculated. Adding all the figures given, Table I, there are 29 cases of cerebrospinal meningitis in 90,037 inoculated and 211 cases in controls, of which only 70,474 are reported. (2) Termination of epidemic. This depends on the percentage of population inoculated. Where it is only 6% as in Riding and Corkill's figures, the results are poor, but where it is from 50–100% as in Zrünek and Feierabend, Russell, Sorel, Le Bourdelles and Sedallian, the epidemic is reported to have disappeared.

The dosage of vaccine varied from 1,000 millions to 10,000 millions (in 3 doses). The best results were always obtained with the largest doses.

TABLE I.—HISTORY OF PREVIOUS PROPHYLACTIC INOCULATION IN CEREBROSPINAL MENINGITIS

Reference	Country	No. inoculated	Dosage	Failures	Controls not inoculated	Cases	Year	Remarks
Greenwood	Gt. Britain	4,000	+++	0	..	..	1916	No control group
Gates	U.S.A.	3,702	+++	3	..	...	1918	No control group
Bruynoghe and Walwarrens	Belgian Congo	3,000	+++	0	8,000	21	1926	
Bruynoghe and Walwarrens	Belgian Congo	14,086	+++	3	3,724	97	1926	100 % inoculation of one group, epidemic disappeared
Le Bourdelles and Sedallian	Belgian Congo	3,004	+++	0	7,867	21	1930	Epidemic disappeared
Zrünck and Feierabend	Czeckoslovakia	22,180	+++	5	19,684	6	1931	Epidemic much reduced in inoculated garrisons
Riding and Corkill	Sudan	[10,198]	+	[9]	[10,133]	[13]	1932	[Results as published.]
Riding and Corkill	Sudan	10,198	+	9	18,187	34	1932	Amended to include all controls
Yacob	India	3,577	+++	2	3,577	6	1935	Epidemic much reduced
Russell	India	1,768	+++	0	1,768	6	1936	Epidemic much reduced
Saleun and Ceccaldi	French Africa	12,666	+	0	0	0	1936	Epidemic ceased two days after 100% inoculation of population
Sorel	French Africa	5,000	+	0	1,768	15	1937	Epidemic ceased
Maclean and Bevan	Cyprus	6,856	++	7	5,899	5	1938	Epidemic reduced to one-third
Totals		90,037		29	70,474	211		

LOCAL CONDITIONS

Cyprus is a British Crown Colony situated in the eastern Mediterranean about 40 miles from Asia Minor and 60 from Syria. It has a greatest length from east to west of about 140 miles, a greatest breadth of about 40, and an area of 3,572 square miles. The island consists of a flat, almost treeless alluvial plain, bounded on the north by a narrow range of limestone mountains reaching an altitude of over 3,000 feet and extending eastwards to form the Karpas Peninsula, while a mountain system occupies most of the south and west. These latter mountains, which are of volcanic origin, reach a maximum height of 6,000 feet and in them important deposits of copper, chromium and asbestos occur.

The climate naturally varies considerably in different parts of the island but seasons follow the same cycle as in England. In the plain there is a short mild winter, during which most of the annual rainfall of about 20 in. occurs and the occasional frosts are experienced ; the summer is long, dry and intensely hot, but on the sea coast, although the temperatures are lower, the humidity is considerably higher.

The official records for Nicosia, the capital, situated in the central plain, show that the maximum recorded shade temperature during the last fifteen years was 111° F., and the minimum was 26° F. On the southern mountain range snow often lies until May, and even at the height of summer the weather is never uncomfortably hot. The prevailing wind is north-westerly, but during the winter there is often a bitter north-east wind from the highlands of Asia Minor.

The estimated population of the island at the end of 1937 was 372,810, about one-sixth of whom were Turkish-speaking Moslems and the majority of the remainder Greek-speaking members of the Orthodox Church of Cyprus. A number of other religions and languages are represented, including Maronites, Armenians, and Jews. As a rule the population can be easily split up into natural groups according to either religion or language, but as Buxton (1920) has shown, this classification should not be applied strictly to race, for, as judged by anthropomorphic characteristics, the Cypriots, whether Moslem or Christian, are a complex racial mixture.

Although a few small industries are developing in the larger towns, and mining in recent years has begun to be developed on an economic scale, the island is essentially rural, and the great majority of the inhabitants are employed in agriculture, living in small villages and often owning their own houses and land. The main towns are connected by a network of tarred roads, but most of the remaining roads have only a clay surface and are often impassable for motor traffic during the winter. However, there are very few villages that are not served by a road of some sort. Village lorries run regularly to and from many of the villages to the nearest towns, and donkeys and mules are still largely used by the villagers. Itinerant tradesmen, such as butchers, tailors and merchants, travel round from village to village. Some of them were proved to be carriers of meningococci and so they were often an im portant means of spreading infection. The standard of living in Cyprus villages, compared with that in England, is still very low. The style of house varies slightly in different parts of the island, but a typical peasant house is a long, narrow, structure, having a central double door with a shuttered, unglazed window on each side ; the total length might be as much as 40 ft., while the width, which is limited by the length of the available timber, is about 12 ft. In the better class houses a central gothic arch or a number of wooden roof-props form a central supporting ridge for the timbers, so that the area of the house can be considerably increased. The floor is composed of dried mud or slabs of local marble, and the roof, which is almost flat, is made relatively waterproof by a covering of clay. A rough fireplace is usually to be seen in houses in the hill villages. Although the more prosperous villager may have a house containing a number of rooms, the average peasant family lives, eats and sleeps in the one room, which also provides shelter for the animals during the night. This latter custom has the advantage of saving the expense of stables and of providing warmth in winter ; moreover it facilitates the feeding of oxen which is customary during the night. It is usual for two or three members of the family to share the same bed, and at night all doors and windows are closely shut. Although this traditional house results in gross overcrowding inside the family circle, the buildings are cool in summer and relatively warm in winter. There does not appear to be much close contact between villagers outside the immediate family circle, except in the village coffee-shop where most adult males gather for the purposes of gambling, talking, and imbibing Turkish coffee and Cyprus brandy.

There is often considerable overcrowding in these village coffee-shops. Sanitation in villages is practically non-existent. Flies are found everywhere. Water is often scarce in summer and is usually obtained from surface wells, although small local piped supplies are gradually being introduced.

The peasant's diet is largely a vegetarian one, local wholemeal bread and olives being the mainstay, while various types of beans, cucumbers and citrus fruits are eaten as well as rice, potatoes, raisins and almonds. Sheep's and goat's milks are

consumed, chiefly in the form of cheese, but cow's milk is rarely used in the villages ; meat is regarded as rather a luxury and in the average household is eaten about once a fortnight. The diet, although bulky, appears adequate, for deficiency diseases are rarely encountered. There may possibly be some shortage of animal protein, but it can be safely said that nutrition is not a problem of great importance in Cyprus.

As the villagers entirely depend on their various seasonal crops for their existence, borrowing of capital is common, and the difficulties arising as a result of rural debts form one of the much discussed problems of Cyprus.

Malaria is highly endemic in many of the villages because innumerable small pools are left in the dried-up streams which form ideal breeding places for *Anopheles superpictus*. Many villages have an infected spleen-rate of 100%.

In the towns, conditions, though still often primitive, approximate to those found in Eastern Europe. The chief change in recent years is to be seen in the mining towns, the most important being the copper pyrites mines in the locality of Lefka, where the Cyprus Mines Corporation employ about 5,000 people and, so, including the dependants of these, the company is responsible for some 15,000 persons. As a result of considerable expansion of this industry during the last few years, villagers from all parts of the island have been attracted by the chance of relatively high wages, and an abnormal concentration of the population has been the result. Building has not kept pace with this expansion, so that houses are expensive and often difficult to obtain. Consequently, a great many people still live out of doors during the summer, but at the onset of winter they crowd together into the available houses. This was the situation at the end of 1936 when the epidemic of cerebrospinal meningitis started, though, as a result of a recent extensive building programme, conditions have improved considerably. Apart from the people actually living in the immediate vicinity of the mines, a great number live in villages within about 10 miles of these mines and come daily to their work. As most Cypriots are essentially agriculturists, they are usually content to work in the mines for a few months only and then return to their crops, perhaps to seek re-employment in the mines when they have sold their produce and spent the proceeds. This continual change of occupation is an important factor as a result of which the mining company may engage in one month twice as many labourers as are on their average pay roll. The conditions existing in the mining area have increased the spread of infection in the recent epidemic of cerebrospinal meningitis ; for not only has it formed a central nidus of over-crowding during the winter months, but it has enabled persons to introduce the infection into the more distant villages.

For purposes of administration, the island is divided into six districts, each of which has a central town which forms the district headquarters. The Government provides a State Medical Service which is run by a few British and a number of Cypriot doctors, with a Director of Medical Services in administrative control. In each of the six district towns there is a general hospital, and the island also has a leper farm and hospital, a mental hospital, a sanatorium and pathological and analytical laboratory. Malaria, typhoid, bacillary dysentery and trachoma are prevalent, and occur more frequently in rural areas than in the towns. Otherwise, disease incidence is roughly similar to that in Great Britain. Surveillance and medical inspection are carried out at the ports and smallpox, plague, typhus, and cholera, though endemic in the Near East, have not been reported from Cyprus for a number of years. A system of compulsory notification of infectious diseases has been in force since 1931.

THE INOCULATION EXPERIMENT

Cyprus is not an ideal country in which to undertake a careful inoculation experiment. Although the epidemic which occurred in 1936–37 gave rise to widespread consternation, it was difficult to predict how the offer of a prophylactic vaccine by

the Medical Department would be received by the villagers. The Government's plan was to inoculate those villages which had shown a heavy incidence during the previous season, and to leave others uninoculated. We soon found it impossible to adhere to our original plans, because the Government found it necessary to make a small charge for each inoculation. The response in some of the selected villages was very poor, and conversely it was difficult to refuse inoculation to the inhabitants of other villages who were not only willing to pay for the vaccine, but clamoured to be included in the prophylactic experiment. Under the circumstances the best available control was the uninoculated member of the family living in the same house as the inoculated.

Both Corkill (1936) and Manoussakis (1930) claimed to have controlled epidemics by reducing the carrier rate—the former by the administration of vitamin A, and the latter by prophylactic inoculation. It seemed advisable to confirm their work and observe the effect on the epidemic by varying the percentage of the population inoculated.

A census was therefore made of all villages inoculated, and a record kept of the number of individuals inoculated in each village. The inoculation and record keeping were carried out by a team which toured the villages under one of us (C.E.B.), then a District Medical Officer. The team consisted of an English District Medical Officer and nursing sister, and a Cypriot staff of two medical officers, a nurse, an accountant, five clerks and three policemen who maintained order. The team travelled by lorry, and visited the villages in Nicosia, Limassol and Paphos Districts, which appeared to have been serious foci of infection during the preceding winter. Although villagers were informed beforehand of the date of the arrival of the team in their village it was usually necessary to spend considerable time and energy on propaganda to ensure a good attendance. The inoculation was carried out in local schoolrooms or coffee shops. Every individual who applied for inoculation had his particulars written down by one of the clerks on a special serially numbered card. A record of the name, age and sex not only of each inoculated individual but also of the other persons living in the same house was made. This was done on the card of only one person out of every household represented. Between the first injection and the second one ten days later, an alphabetical list was made of all inoculated persons in each village visited. By a system of cross reference it was then a simple matter to find out for any inoculated individual how many persons lived in the same house and how many of these had not been inoculated. The latter formed the control group. The Government team worked from October 4 to November 18, 1937, by which time it had inoculated 6,856 people.

While the team was touring the villages Dr. P. Smitten, Medical Officer of the Cyprus Mines Corporation, had already started to inoculate the employees at the mines and as many as possible of their wives and families. This continued for the greater part of the epidemic season, as the company was continually taking on new labour. These two campaigns were run quite independently but we are indebted to Dr. Smitten for the details of all those inoculated by him. At his suggestion all individuals who were inoculated received a minute intradermal injection of 25% solution of Indian ink into the scapular region for each dose of vaccine administered. This produced a permanent tattoo mark ; and, except for two cases injected on the first day of the campaign in which slight skin necrosis occurred, no complications were observed.

The inoculation campaign of the Cyprus Mines Corporation started at the end of September 1937, and the greater part of the work was completed during October and November, although a certain number of inoculations were still being done throughout the whole season. Over 6,000 persons connected with the mines were inoculated by the end of 1937.

For local administrative reasons a great number of people were inoculated who

were outside the sphere of the experiment as originally planned. The rough figures are given here, but the results of these other inoculations are not discussed further owing to the impossibility of making reliable analysis. Thus, over 5,000 people were inoculated in the six district towns and nearly 8,000 school children scattered throughout Limassol and Paphos Districts. Including the above and eight villages that were inoculated during December 1937 and January 1938, together with a number of secondary schools, prisons, and two other mining concerns, over 30,000 persons received the inoculation course of two injections. This amounts to about 8% of the estimated population of the island in 1937. Over 12% of the inhabitants of the Districts of Nicosia, Limassol and Paphos, which contained the bulk of the cases during the first wave, were inoculated. The position of the various inoculated centres are shown in Map 4, with the exception of the school children in Limassol and Paphos Districts.

During the 12-month period starting from October 1, 1936, there were 836 cases and 284 deaths reported in the whole island, while in the next twelve months starting from October 1, 1937 (i.e. including and following the inoculation campaign), 298 cases and 81 deaths occurred. That is to say that the incidence of the disease during the second wave was reduced to 36% of that of the first wave, and the number of deaths to 29%.

During the third wave up to the end of May 1939 there were 123 cases reported and the deaths were 51. An occasional case may occur during the rest of the third period which finishes at the end of September 1939, but judging from past experience the final figures for the third period will not alter much from those quoted above. It will be noticed that there is only a slight fall in the death-rate in the second period and this in spite of the fact that during the second wave of the epidemic there was the additional help of sulphanilamide in the treatment of the disease. It must therefore be recognized that although the number of cases was greatly reduced, those cases which did occur were more severe clinically than those of the first wave. We think that this increase in the severity of the disease fits in quite well with the suggestion made later in the paper that in the presence of prophylactic inoculation only strains of increased virulence are capable of causing cerebrospinal meningitis.

When we try to account for the marked fall in the total number of cases during the second period we find that conditions were equally favourable during both years for the continuance of the epidemic. As shown in Graph I meteorological conditions appear to be little altered in the two periods. There had been some improvement in the housing conditions in the actual mining towns, but this did not affect the great bulk of the mining population who lived in neighbouring overcrowded villages. The great reduction in the number of cases between the two waves was just as marked in these villages as in the improved housing area of the towns. We were led to expect from the 1908–1910 epidemic in Cyprus and also from the history of recent epidemics of this disease in contiguous countries such as Egypt and Asia Minor that the case incidence would be just as great in the second year as in the first. We think it unlikely that we were fortunate enough to start our inoculation campaign when the epidemic was subsiding and so be led to a false conclusion. With the exception of the three district towns and one mining centre, no inoculations were performed in the Famagusta, Larnaca and Kyrenia Districts: the population of which amounts to over one-third of that of the whole island. These three districts had 48 cases during the first wave, and 78 during the second. Therefore, although the epidemic as a whole has been considerably reduced, this reduction has been limited to the inoculated area, while in the non-inoculated area, the incidence, though small, has actually increased.

The results of the original experiment are set out in Table II which gives the cases and deaths occurring in the twelve months following October 1, 1937. Care has been taken to exclude from the control group all persons who, subsequent to the visit of the Government team to their villages, were later inoculated by the Cyprus Mines

TABLE II.—INCIDENCE OF CEREBROSPINAL MENINGITIS, 1937–38, IN INOCULATED
AND CONTROL GROUPS.

|		Population at risk	Cases	Cases per 1,000	Deaths
Inoculated	..	6,856	7	1·0	1
Controls	..	5,899	5	0·9	0

Corporation.   Only those individuals who received two injections are considered. It shows that the case incidence in both groups is very small, there being no significant difference between the two groups.   Reference to Graph I shows that the incidence of the disease had dropped very considerably although the reduction was much more marked in the three districts under consideration.   The distribution of the cases is shown on Maps 1, 2, and 3.

The reduction in the inoculated area seemed to be so marked that a closer analysis has been made.   As already mentioned, a census was made of the villages inoculated by the team, but unfortunately it has not been possible to get this done for all the villages where cases had occurred during the first wave.   The population of these other villages was therefore obtained by calculating the annual increase from populations given in the 1921 and 1931 Census Reports.   The actual mining towns are excluded from this analysis, owing to the improvement in housing that had been made after the first wave and the very considerable movements of the population that were continually taking place.   By combining the figures of the Government team and the details obtained from the Cyprus Mines Corporation it was possible to determine the total number of persons inoculated in every village and so the percentage inoculation of each village.   The results for Nicosia, Limassol and Paphos Districts are set out in Table III and Graph II.   The first wave includes cases notified in the twelve months from October 1, 1936, and the second wave cases from October 1, 1937.   The data are taken from the official notification cards which are dated, on the average, about one week after the date of onset of disease. Group A villages have 10% or more of the inhabitants inoculated, the maximum figure for any village being 72%.   The figures are derived from 5,824 persons inoculated by the team and 1,373 by the mines.   The majority of Group B villages were not inoculated, although one village had 7% of its inhabitants inoculated, and the next highest village had 4%.   A number of them probably had one or two persons inoculated who had returned from the mines ; the group as a whole, however, can be regarded as non-inoculated.   There were eight villages which according to the original plan would not have been inoculated, but for reasons explained earlier it was often impossible to adhere strictly to this programme.   These eight villages— Group C—were inoculated as follows, one in November, three in December 1937, and four in January 1938, immediately following the notification of the only cases that occurred in these villages.   Table III and Graph II, therefore, contain every village which had a case of cerebrospinal meningitis during the first wave ; the only cases that are excluded are those occurring in the three district towns and in the actual mining centres.

TABLE III.—INCIDENCE OF CEREBROSPINAL MENINGITIS IN INOCULATED (GROUP A),
NON-INOCULATED (GROUP B) AND LATE INOCULATED (GROUP C)* VILLAGES.

Group	Number of villages	Population	Cases 1st wave	↓ Prophylactic Inoculation 2nd wave	Cases per 1,000 1st wave	2nd wave
A	46	24,893	296	27	11·9	1·08
B	150	73,327	308	83	4·2	1·13
C	8	5,081	36	9	7·1	1·77

* These villages were inoculated during the epidemic period.
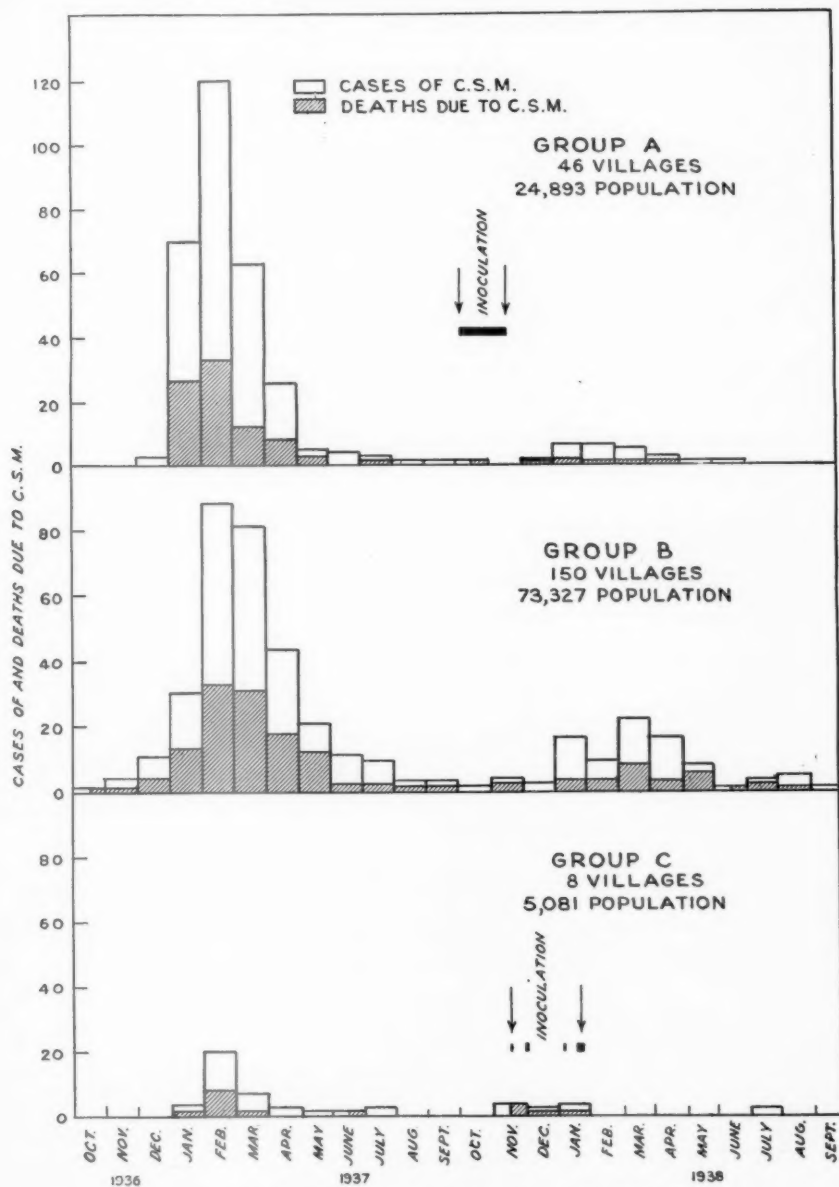
GRAPH II.—Inoculation experiment.   Groups as in Table III.

The figures show a considerable reduction in the number of cases in both groups in the second wave as compared with the first. This reduction is to one-eleventh in the cases of Group A, and to less than a quarter in Group B. In Group C during the first wave there was a typical curve with the maximum number of cases in February, but during the second wave the epidemic stopped quite suddenly in January, following inoculation. In considering the comparatively high incidence during the second wave in this group it must be remembered that most of the cases occurred before inoculation.

The results show that there has a been a general reduction in the number of cases in all the areas. As the greater reduction in Group A villages may have been due to the acquired immunity of the susceptible individuals as a result of the high incidence during the first wave, it is not claimed that inoculation was the sole cause in this reduction. As against this the course of the epidemic in the mining town is interesting. Inoculation was carried out in this area until the expected peak of the epidemic in February and March 1938. After a big campaign in October and November 1937, the inoculation was largely confined to fresh recruits who during the second period there have provided a continual influx of new and presumably susceptible people to the mining area. Most of these were inoculated on arrival. In spite of the influx there was a reduction from 75 to nine cases. Since it has been impossible to obtain an accurate census of these towns, because of the recent expansion, calculations from the census are misleading. A rough estimate of the population, however, would be about 10,000 which would give 7·5 and 0·9 cases per 1,000 during the first and second waves respectively. This reduction is much greater than in the Group B (non-inoculated villages), shown in Table III.

In order to attempt to separate these various factors the villages shown in Table III have been further subdivided. In Table IV all villages with over 20 cases per 1,000

TABLE IV.—INCIDENCE OF CEREBROSPINAL MENINGITIS IN " INOCULATED " (A1 AND A2) AND " NON-INOCULATED " (B) VILLAGES ARRANGED ACCORDING TO INCIDENCE AND AMOUNT OF INOCULATION.

Group	No. of villages	Population	Cases 1st wave	Cases 2nd wave	Cases per 1,000 1st wave	Cases per 1,000 2nd wave
(0–) A1 (heavy)	3	1,875	6	0	3·2	0·0
A2 (light)	6	3,712	13	2	3·5	0·54
B	84	56,494	137	54	2·4	0·96
(5–) A1 (heavy)	6	3,559	23	3	6·4	0·83
A2 (light)	6	4,782	30	7	6·3	1·46
B	36	11,629	76	16	6·6	1·37
(10–20) A1 (heavy)	6	4,000	57	5	14·3	1·25
A2 (light)	8	3,192	48	9	15·0	2·82
B	25	5,484	73	14	13·3	2·55

A1 = villages with over 30% of the population inoculated.
A2– = villages with under 30% of the population inoculated.
0– = villages where there were less than 5 cases per 1,000 during the first wave.
5– = villages where there were more than 5 but less than 10 cases per 1,000 during the first wave.
10–20 = villages where there were 10–20 cases per 1,000 during the first wave.

during the first wave have been excluded in order to eliminate the effect of any possible rise in resistance of the population. The remaining villages have been divided according to the incidence during the first wave into groups with 0–, 5– and 10–20 cases per 1,000 of the population living during the first wave. The villages in Group A of Table III have been further divided into : Group A1, heavily inoculated villages (30–72%) ; and Group A2, lightly inoculated villages (under 30%). It can be seen that in all groups there is a very considerable reduction in incidence in the second wave compared with the first. When rates of 20 per 1,000 and under are considered,

villages with a high incidence in the first wave tend to have a comparatively high incidence in the second wave. All the groups in Table IV have comparable figures in both waves except Group A1 in the second wave where the reduction is much better than in either of the other two groups. This reduction in the heavily inoculated Group A1 is always 100% better at least than in either of the other uninoculated or inoculated groups. This suggests that prophylactic inoculation has some effect in reducing the incidence of the disease. However, we are aware that our inoculation experiment was not perfect and open to criticism, and we therefore cannot claim that prophylactic inoculation was the sole cause of the better results obtained in the second wave. The various groups were not equal in number nor were they pre-selected. Also, owing to the limitations of our experiment the inevitable patchy distribution of inoculated persons, even in highly inoculated villages, would enable cases of the disease to occur as a result of contact with many non-vaccinated individuals. In view of these fallacies it does not seem advisable to apply tests of significance to any of our figures, and no final conclusions can be drawn. We do, however, consider that our results are compatible with a prophylactic vaccine being effective in controlling an epidemic of cerebrospinal meningitis, although we wish to state that statistically we have been unable to prove our point.

THE PREPARATION OF THE VACCINE

It was impossible to examine serologically many of the strains which occurred during the epidemic. Twenty strains were tested with the Oxford Standard Group I and II sera, and twelve of these gave good agglutination to a titre of at least 1 : 100 with Group II and none to 1 : 50 with Group I. Eight strains were labelled inagglutinable as no agglutination occurred with these strains at a titre of 1 : 10. Unfortunately, a large number of strains brought home to England did not survive the journey and the opportunity for further serological work was lost.

The vaccine used in Cyprus was supplied by Messrs. Parke, Davis & Co., London. It contained 14 strains of meningococci belonging to Gordon's Types I, II and III. No Type IV was available in England at that time nor were any of the local strains from Cyprus. All the strains were supplied by Dr. Scott of the Ministry of Health Laboratories, London. The vaccine was grown for twenty-four hours on boiled blood-serum agar and killed by heat for one hour at 60° C. and sent out at 1,000 million organisms per cubic centimetre. The dosage was $\frac{1}{2}$ c.c. and 1 c.c. at ten days' interval. Any reactions which occurred were slight and no serious accidents of vaccination were reported by the team.

In view of our few inoculated failures we recommend a larger dosage for use in future—2,000, 4,000, 4,000 millions at weekly intervals. The vaccine should be made from recently isolated strains and kept in cold storage until just before use, so as to prevent autolysis.

THE OCCURRENCE OF CEREBROSPINAL MENINGITIS IN INOCULATED PEOPLE

There were 14 cases of meningitis reported in inoculated people up to the end of April 1938, i.e. during the time of the survey. Two of these cases died : one in twelve hours, before any bacteriological examinations could take place. The other died in six days, and her illness was complicated by lobar pneumonia : pneumococci and meningococci being found in her cerebrospinal fluid.

Of the other 12, two were definitely diagnosed as pneumococcal ; one had pneumococci and meningococci in the cerebrospinal fluid, and in five more cases which occurred in the outlying districts no material was sent to the laboratory for diagnosis. Accordingly only seven out of 14 were diagnosed definitely as being

meningococcal. Of these three were complicated by the presence of pneumococci. The impression left was that cases of cerebrospinal meningitis occurring in inoculated people were more severe than in the non-inoculated. The vaccine did not prevent the occurrence of complications, as two of the cases had meningococcal arthritis, and one of these also had an orchitis.

EPIDEMIOLOGY OF CEREBROSPINAL MENINGITIS AS FOUND IN CYPRUS

Epidemic cerebrospinal meningitis occurs especially during the late winter and spring ; that is, in the season of nasopharyngeal catarrhs, pneumonia, and influenza. The weather at the time of the epidemic is usually colder and wetter than normal for the locality. Many people have shown that during an epidemic of catarrhs the carrier rate for meningococci rises quickly and in spurts. In a susceptible community this sudden increase in the carrier rate is often accompanied by cerebrospinal meningitis, but, as stated by Dudley and Brennan (1934), this is not necessarily so. They swabbed the inhabitants of two naval garrisons at fortnightly intervals for a period of fourteen months. Chatham had a carrier rate of 50% with no cases of meningitis ; Portsmouth had a carrier rate of 5% with six cases of meningitis. They explain this by surmising that at Chatham there was a strain of great infectivity but of low invasiveness, while at Portsmouth the strain was of high invasiveness but low infectivity.

While the carrier rate is high we presume that the meningococci are being rapidly passaged from man to man. We know from experiments that if the meningococcus is rapidly passaged through animals in the presence of mucin it quickly gains in virulence. Thompson (1920) also claimed to have observed this increase in virulence during the sudden increase in the carrier rate in human beings. Laybourn (1936) found that it was possible during catarrhal periods for the meningococcus to make a daily change of host ; if at each change it gains only a little in virulence it will eventually reach a susceptible person with sufficient virulence to cause him to contract cerebrospinal meningitis.

In discussing the passage of the meningococcus the Ministry of Health Report on Cerebrospinal Meningitis, No. 65, says :

"While the transmission of the meningococcus from person to person is common, it is unusual for a patient to have been infected by another patient suffering from cerebrospinal fever. For every case of meningococcus infection which results in cerebrospinal fever, there are many more which do not. Neither the one class nor the other may ever have been in known contact with a cerebrospinal fever patient ; they have derived their infection from persons who, if they have been ill at all, have shown no certain signs of infection of the cerebrospinal system. In other words, the great majority of infections are derived from persons who, for the time being, are unrecognized carriers of the meningococcus."

Arkwright (1915) concluded that :

"Meningococcal infection is not so much an epidemic of cerebrospinal meningitis as an epidemic of saprophytic meningococci in the nasopharynx—cerebrospinal meningitis is an epiphenomenon associated with increased virulence."

Neither of these last two authorities explains why the " epiphenomenon " of cerebrospinal meningitis suddenly occurs but we suggest that it is possibly due to the increased virulence of the meningococcus which it acquires during its rapid passage from man to man. In Cyprus, we recorded many instances of the rapid transference of catarrh inside the family circle, and it was noticeable that it was only the last victims of the common infection who developed meningitis. Unfortunately, as these histories could only be obtained after the cases had occurred we have no

bacteriological confirmation that the meningococcus was being passaged with the
other catarrhal organisms.   Luckily, while carrying out routine swabbing in an
epidemic area we were able in a case of cerebrospinal meningitis to demonstrate
the rapid passage of the meningococcus in association with catarrh (Table V).   The
village had suffered from an epidemic of catarrh for three weeks during which cases
of cerebrospinal meningitis had occurred.   Bi-weekly swabbings were being done of
all contacts and in the families of last year's cases.

TABLE V.—A CASE OF CEREBROSPINAL MENINGITIS FOLLOWING RAPID
PASSAGE OF MENINGOCOCCI.

Subject	Age	Previous history	Swabs for meningococci 1938		
			Feb. 2	Feb. 5	Feb. 9
Boy	5	Case cerebrospinal meningitis, 1937	+	+	+
Girl	9	Carrier, 1937	+	−	−
Baby	5/12	..	−	+	+
Mother	29	..	−	−	+
Father	30	Nursed son during 1937	Away from home	Away from home	+ Developed cerebrospinal meningitis Feb. 11

The father was away from home attending his sheep for ten days.   He returned
home after the meningococcus had reached the fourth member of the family.   He
did not associate with anyone else in the village and contracted cerebrospinal
meningitis three days after returning home.   Two people who associated with him
after he was attacked developed cerebrospinal meningitis within a few days.

We know that there is great variation in the susceptibility of different people
to cerebrospinal meningitis.   This difference in immunity may be artificial ;   for
example, by reason of fatigue, excessive use of alcohol, dust, concurrent disease ; or
it may be actual, for example in the youngest members of the family, new recruits,
shepherds, &c. If we concede that immunity can be artificially raised by vaccines—
Sophian and Black (1912), Kolmer and Rule (1938), it is reasonable to suppose that
prophylactic inoculation will reduce the number of susceptibles in a given
population.

In the review of prophylactic inoculation against cerebrospinal meningitis quoted
above, we see that there have been three cases per 1,000 inoculated, which compares
favourably with the failure rate in antityphoid inoculation of 5·6 per 1,000 (Anti-
typhoid Committee, 1913). If our contention that *rapid passage* increases the virulence
of a meningococcus is valid, then there must come a stage when even a well-immunized
man will meet a strain of meningococcus whose invasiveness is so increased that he
will succumb to cerebrospinal meningitis.

In England, where the carrier rate is high in winter, there must be a fair degree
of immunization taking place ;   in Cyprus and in the tropics, where the carrier rate
is low (1% to 2%, with an increase to only 5% to 10% in epidemic periods), there
is less chance of acquiring immunity.   In support of this, we note that England has
only a few sporadic cases, as compared with the much higher morbidity in Cyprus
and the Tropics.   Where the carrier rate returns to a low level for most of the year
the disease occurs in epidemic proportions. We suggest that the greater the proportion
of the population that are inoculated the better are the chances of preventing the
epidemic.   We would go so far as to propose that the surest way of preventing the
rapid passage of the meningococcus in a community is to inoculate the whole
population.

In view of the accepted association between epidemics of cerebrospinal meningitis
and epidemics of influenza and catarrhal infections, we must consider whether it

would be advisable to employ specific measures to prevent epidemic catarrhs occurring in the presence of chronic meningococcal carriers. It would be interesting to see whether a vaccine, consisting not only of meningococci but also of all the usual catarrhal organisms, would be more effective than a plain meningococcal vaccine in controlling both the carrier rate and the incidence of meningitis. We know that vaccination will not sterilize a chronic carrier, but it is conceivable that large scale prophylactic vaccination among his contacts would limit his potential infecting power. It may require many passages from the carrier before his avirulent strain acquires sufficient virulence to cause meningitis.

CONCLUSION

In view of the evidence that is put forward that this disease may be spread by *rapid passage*, and the suggestion that wide scale inoculation might limit this pheno-menon and so indirectly control an epidemic, we consider that no satisfactory experi-ment has yet been published. In this criticism we include our own work. We therefore make the following suggestions as to how, in our opinion, an experiment should be conducted in the hope of arriving at more conclusive results :

(1) The carrier rate of a number of " islets " of the population should be deter-mined before starting the inoculation campaign.

(2) The " islets " should then be divided into two known groups, which should be equal in all respects, including the carrier rate at the time and previous experience of the disease. There should be no direct communication between the two groups.

(3) One group should be 100% inoculated and no inoculations should be done in the other group. All inoculations should be free of charge and compulsory.

(4) The vaccine should contain local strains of meningococci and common catarrhal organisms.

(5) The *complete weekly carrier rate* of each group should be determined for the whole season starting from the day of inoculation.

(6) The introduction of carriers and new arrivals from outside the groups should be limited as far as possible.

(7) In every case occurring in the groups the patient's movements during the incubation period should be carefully investigated, and all possible contacts swabbed with the object of determining any sources of infection introduced from outside the group.

(8) A full-time bacteriologist with a laboratory within easy reach of the groups under observation is necessary for reliable results. Experience has shown us that not more than 50 specimens a day can be dealt with satisfactorily.

(9) If the results of such an experiment appeared favourable it might be worth repeating the work with a different percentage of the groups inoculated. In this case the inoculated persons should be distributed evenly throughout the group.

REFERENCES

" Anti-typhoid Committee Report ".   London.   (1913.)
ARKWRIGHT, J. A. (1915), *Brit. M. J.* (i), **494.**
BRUYNOGHE, R., and WALWARRENS, P. (1926), *Compt. rend.Soc. de Biol.*, **95**, 872.
BUXTON, L. H. D. (1920), *J. Roy. Anthrop. Inst. Great Britain and Ireland*, **50**, 183.
CORKILL, N. L. (1936), *J. Trop. Med.*, **39**, 1.
DAVIS, J. (1907), *J. Infect. Dis.*, **4**, 558.
DUDLEY, S. F., and BRENNAN, J. R. (1934), *J. Hyg.*, **34**, 525.
GATES, F. (1918), *J. Exper. Med.*, **28**, 449.
GREENWOOD, M. (1916), *Proc. Roy. Soc. Med.*, **10** (Sect. Epidem., 44).
KOLMER, J. A., and RULE, A. M. (1938), *Am. J. Clin. Path.*, **8**, 1.
LAYBOURN, R. L. (1936), *Am. J. Pub. Health*, **26**, 979.
LE BOURDELLES, B., and SEDALLIAN, P. (1930), " Prècis d'Immunologie ".   Paris.
MANOUSSAKIS, E. (1930), *Bull. Acad. de mèd., Paris*, **104**, 155.
NEFF, E. A., and MARKIDES, C. S. (1937), Ann. Med. and San. Rep., Cyprus.
" Reports on Public Health and Medical Subjects ", No. 65, Ministry of Health.   (1931.)
RIDING, D., and CORKILL, N. L. (1932), *J. Hyg.*, **32**, 258.
RUSSELL, A. J. H. (1936), *Bull. Office internat. d'hyg. pub.*, **28**, 1106.
SALEUN, G., and CECCALDI, J. (1936), *Bull. Soc. path. exot.*, **29**, 996.
SOPHIAN, A., and BLACK, J. (1912), *J. A. M. A.*, **59**, 527.
SOREL (1937), *Bull. Office internat. d'hyg. pub.*, **29**, 288.
THOMSEN, O. (1925), *Senchenbekämpfung*, **2**, 10.
YACOB, M. (1935), *Indian M. Gaz.*, **70**, 502.
ZRŪNEK, K., and FEIERABEND, B. (1931), *Trav. Inst. d'hyg. pub. de l'État Tchécoslovaque*, **2**, 1.

Discussion.—Dr. J. D. ROLLESTON said that he had listened with much interest to the paper as comparatively few publications on the prophylaxis of cerebrospinal fever had appeared.   He referred to the paper by Major Greenwood read many years ago before the Section relating that of 4,000 persons inoculated none had developed the disease.   Bruynoghe, who carried out vaccination against cerebrospinal fever in the Belgian Congo, reported that the disease was at least ten times less frequent among those given three injections of the vaccine than among the controls.   On the other hand active immunization carried out on a large scale by Zrūnek and Feierabend in the Czechoslovak army proved ineffective, as the incidence of the disease was little less among the inoculated than among the controls.   Apart from the actual occurrence of epidemics, Terry and Steele had tested 605 children with a meningococcus toxin of whom 66·8% gave a negative reaction after being retested.

Dr. Rolleston said that it was obvious that in addition to active immunization other prophylactic measures were required, especially improvement in hygiene.   He asked if the radio and cinema had been used for this purpose or if health visitors were employed in Cyprus.

References.—BRUYNOGHE (1928), *J. de méd. de Paris*, **48**, 1005 ; GREENWOOD, M. (1916-17), *Proceedings*, **10** (Sect. Epid. 44) ; TERRY, N. S. and STEELE, A. H. (1935), *J.A.M.A.*, **104**, 983 ; ZRŪNEK, K., and FEIERABEND, B. (1931), *Trav. Inst. d'hyg. pub. de l'État Tchécoslovaque*, **2**, 1.

Professor ALEXANDER FLEMING congratulated the authors on a fine piece of work and expressed the opinion that in view of the results obtained in Cyprus it was very desirable that other similar observations should be made.   It seemed to be brought out that in an investigation of this sort the authorities should not stint facilities and especially laboratory facilities, if the best results are to be obtained.   Listening to the paper he had gathered that the authors started with an ambitious laboratory programme but as the epidemic progressed more and more of it had to be dropped and if another such experiment is made there should be a larger pathological staff so that the various problems could be investigated on the spot.

Dr. H. STANLEY BANKS asked whether the type of meningococcus isolated from carriers had been determined.   He understood that meningococci of Group II and anomalous types isolated from healthy people were frequently harmless saprophytes.   In the cases inoculated during the currency of the epidemic, had any evidence been obtained of the influence of the " negative phase " as a predisposing cause of the disease ?   He inquired also what opinion was formed of the efficacy of the drug treatment of the disease and what was the dosage employed.

Lieutenant-Colonel J. S. K. BOYD said that it seemed possible that there were circumstances, other than those commonly recognized, which played a part in causing or preventing an outbreak of cerebrospinal meningitis. He recalled an occasion in Simla in 1935, when the stage seemed set for a serious outbreak, yet none occurred. All the conditions postulated by previous speakers were present—overcrowding of the worst kind, a low standard of living, severe physical exertion (for man there is the beast of burden), high humidity, a prevalence of catarrh, and a swollen population consisting partly of immigrant coolies from cities of the United Provinces and Punjab where there was at that time a severe outbreak of cerebrospinal meningitis, and partly of unsalted hillmen from the mountainous hinterlands. The occurrence of two or three cases proved the presence of the infective agent : the absence of any further manifestations suggested that some essential factor necessary for the establishment of widespread infection, additional to those already mentioned, was lacking.
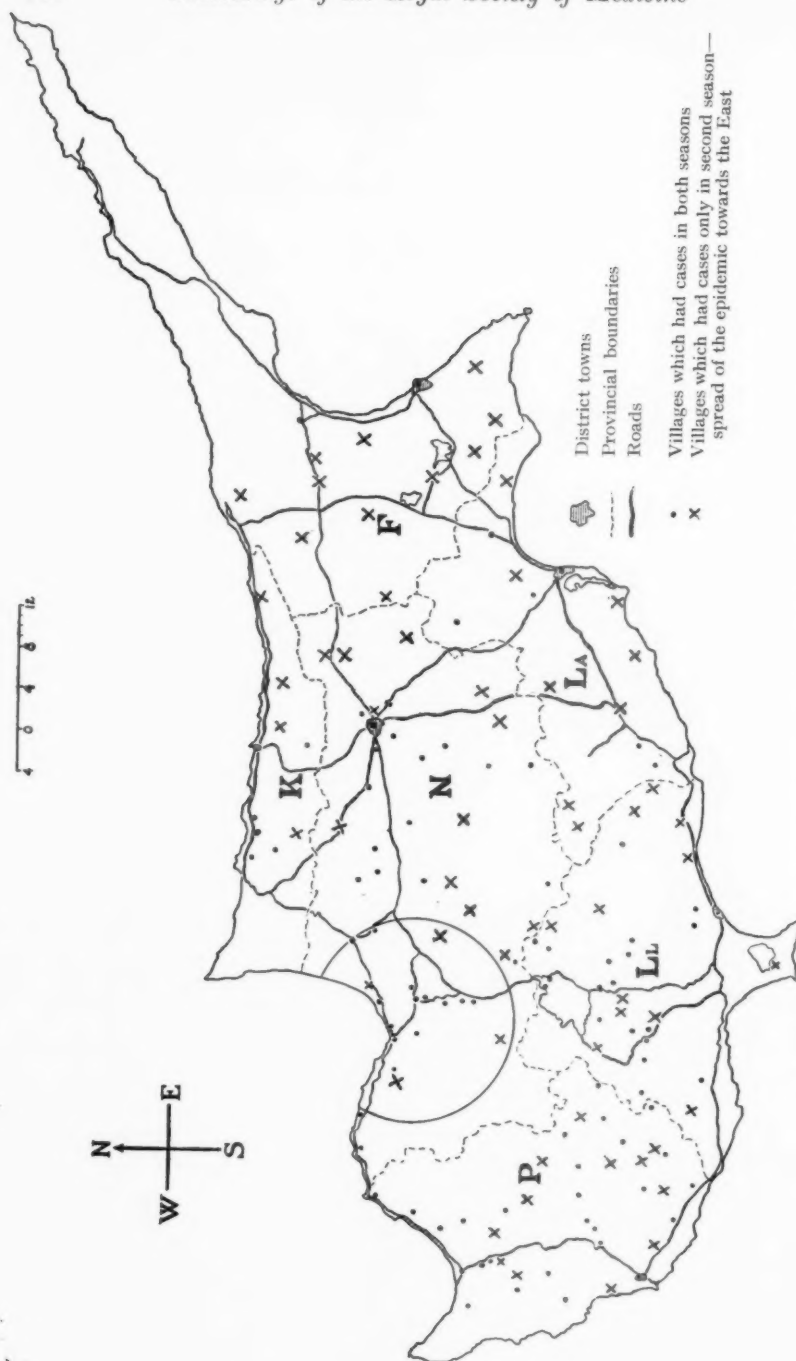
Dr. MACLEAN (in reply) disagreed with Dr. Rolleston that Zrûnek and Feierabend had failed with preventive inoculation. As stated in this paper they had been quite successful where 50% of the population had been inoculated. Their conclusions were too modest and not in agreement with the facts stated in their paper. There is no local radio nor is there a village cinema. The schoolmaster made a very good health propaganda agent.

In reply to Dr. Banks, Dr. MacLean said that some of the strains isolated from carriers were proved to be Group II, but most of them were inagglutinable. There were no means of testing the virulence of individual strains locally. No cases of "negative phase" were noticed after the vaccine, in fact even when the disease was present in the neighbourhood there were no severe reactions. The treatment of cerebrospinal meningitis by the sulphanilamide group of drugs was to be fully reported elsewhere. It is sufficient here to say that it was a great success when given in adequate doses early in the disease. The failures of the drug treatment were in the most virulent forms of the disease where the treatment had to be delayed. The dosage was small when compared with European dosage (1 — 2·5 grm. per day for four to five days) and there was usually a period about the tenth day when the disease tended to relapse and the drug had to be repeated for a few days.

In answer to Lieutenant-Colonel Boyd, he thought that conditions at Simla in 1935 must have been similar to those in Chatham in 1934 as reported by Dudley and Brennan.
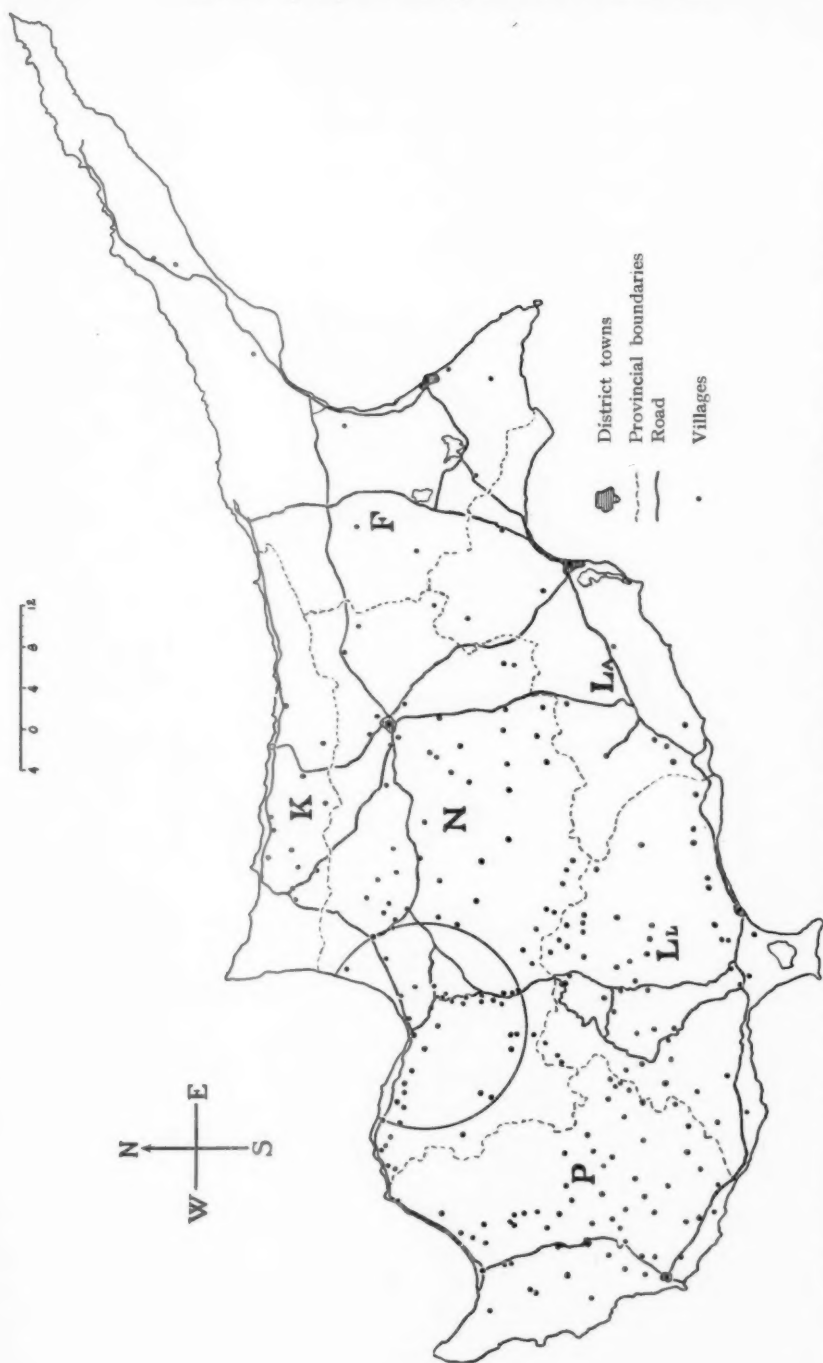
Map 1.—Cyprus. Distribution of cases of cerebrospinal meningitis during first season (1936-37) by villages. Area inside circle is the mining area which was the principal focus of infection (*see also* Map 3). K, N, F, La, Ll, and P represent the districts of Kyrenia, Nicosia, Famagusta, Larnaca, Limassol, and Paphos.

District towns

Provincial boundaries

Roads

Villages which had cases in both seasons

Villages which had cases only in second season—
spread of the epidemic towards the East

MAP 2.—Distribution of cases of cerebrospinal meningitis during second season (1937-38).
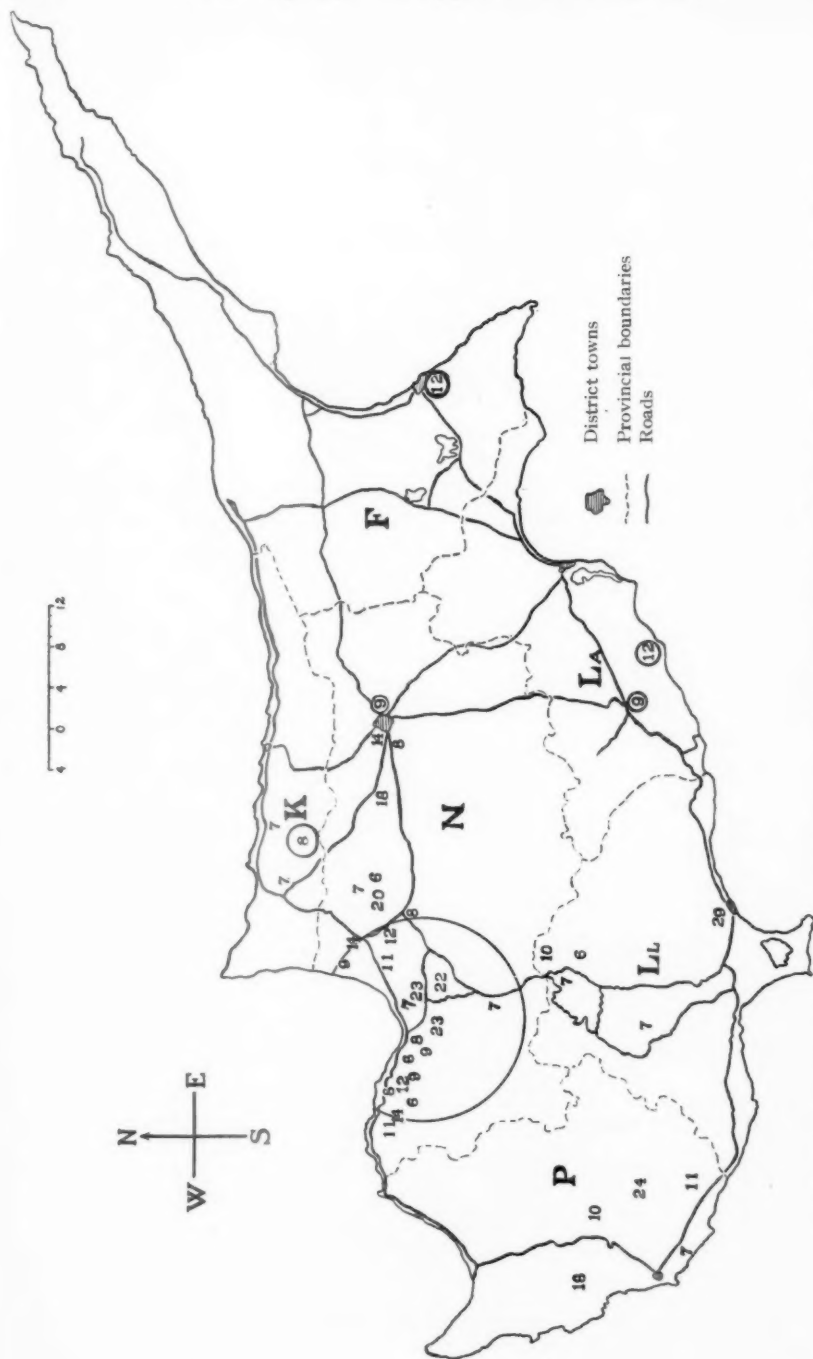
MAP 3.—Distribution of cases of cerebrospinal meningitis (1936-38). Only villages with more than five cases are shown.

Figures represent number of cases in village during first season only, e.g. 12.

Figures in circles represent number of cases in village during second season only, e.g. ⑫.
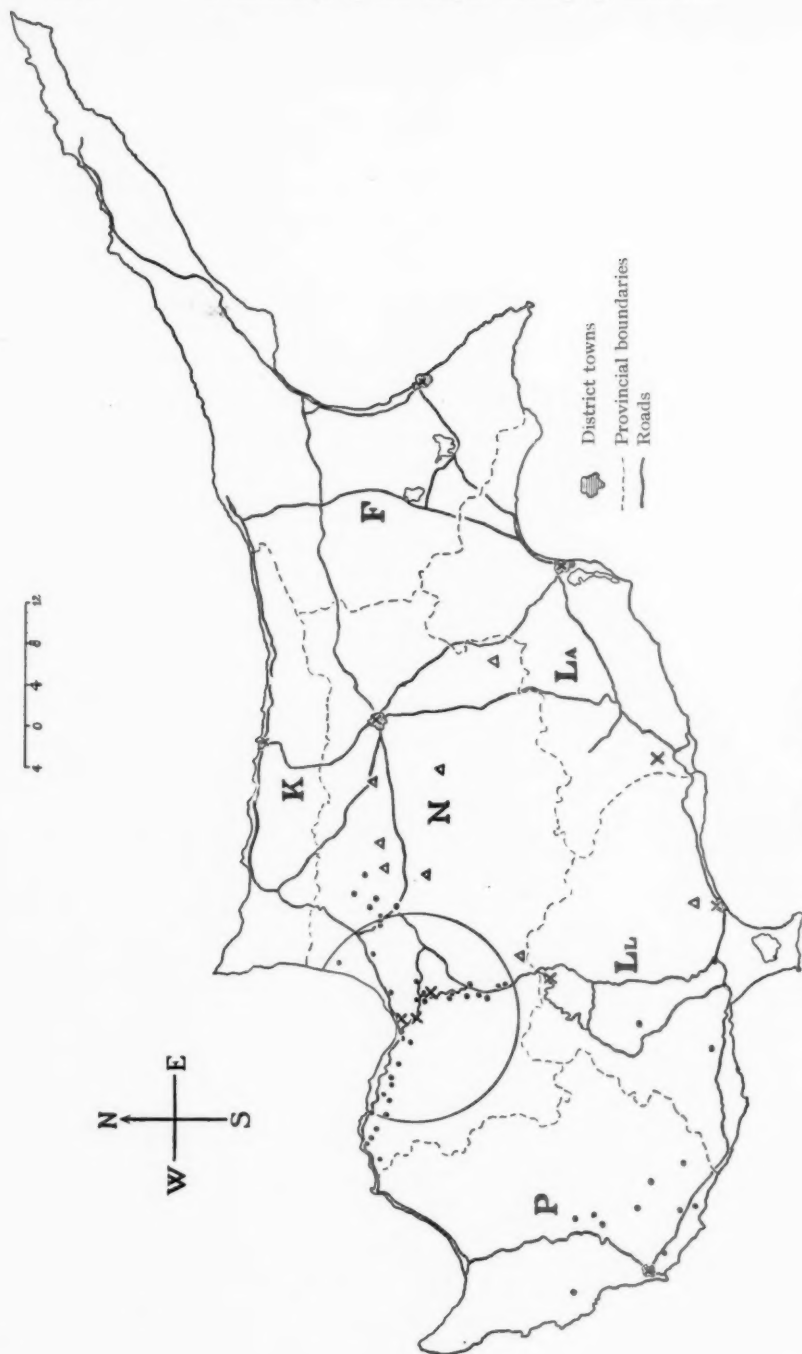
Map 4.—Inoculation experiment.

•   Villages chosen by team for inoculation (October 4—November 18, 1937).

▲   Villages inoculated December 1937—February 1938.

✕   Other towns and centres inoculated, but outside the experiment.

District towns

Provincial boundaries

Roads

Section of Dermatology

President—H. HALDIN-DAVIS, F.R.C.S.

———

[*June 22*, 1939]

Leukæmia with Nodules in the Skin.—G. B. MITCHELL-HEGGS, M.D.

J. P., male, aged 43 ; estate agent.

Past history.—In 1937 patient noticed a rash which he compared with a heat rash and which spread gradually from the arms all over the body. There was no irritation. He felt quite well but lesions appeared to be worse when he was at all worried. Condition present throughout the summer.

Treatment.—Calcium chloride, detoxin, proseptasine, and omnadin injections. Homœopathic treatment, arsenic, bee-sting, and belladonna. Teeth removed. Later swellings appeared on the feet and there was difficulty in walking. For this he took herb salts and phensic twice daily.

Previous history.—Common illnesses of childhood ; always tendency to colds.

Family history.—No history of skin or blood disease. One sister suffered from asthma and periodic red patches on the skin.

On examination.—The patient is a spare man and his skin has a brownish tinge with numerous red, raised nodules, some pale or white in the centre. On the legs the nodules have a purplish tinge.

No weakness in arms or legs ; no loss of sensation ; reflexes brisk. Tonsils enlarged ; tongue smooth, pale and shiny. No enlargement of spleen. Symptoms and signs suggest pernicious anæmia without signs of subacute degeneration.

Blood Wassermann reaction negative.

First blood-count : R.B.C. 2,150,000 ; Hb. 55% ; C.I. 1·2 ; size 7·5 μ ; W.B.C. 10,800. R.B.C. show marked anisocytosis, poikilocytosis, and polychromasia.

Second blood-count : R.B.C. 2,100,000 ; Hb. 46% ; C.I. 1·0 plus ; size 7·5 μ ; W.B.C. 6,000 (neutros. 23% ; eosinos. 3% ; basos. 4% ; lymphos, small 6%, large 18% ; monos. 48%). Immature cells : Erythroblasts 2 per 100 W.B.C. R.B.C. show anisocytosis and poikilocytosis and minor degree of polychromasia.

Biopsy report (Professor Newcomb) : There is a subacute inflammation of the deeper parts of cutis and subcutis. Numerous leucocytes, plasma cells, and lymphocytes, are surrounding the sweat-glands and vessels.

Additional note by Dr. Freudenthal : A cellular infiltration mostly perivascular, especially around sweat-glands in the cutis, and also subcutis, suggestive of some proliferative process of the reticulo-endothelial system.

Discussion.—Dr. I. MUENDE : As the lesions appeared and disappeared spontaneously and the histology has no distinctive features, if it were leukæmia would it not belong to the group of eruptions in leukæmic conditions which are non-specific ?

Dr. F. PARKES WEBER : The clinical appearance of the dermatosis is something between urticaria and an exudative erythema. In regard to the nature of the blood condition I think that one should wait a little and re-examine before deciding. Treatment by liver, &c., could be continued in the meantime.

Dr. MITCHELL-HEGGS : I agree with Dr. Muende's observations, but it struck me that some of these lesions were rather more permanent than one expects in urticaria or erythema multiforme.

? Granuloma Annulare.—G. B. MITCHELL-HEGGS, M.D.

A. E., male ; confectioner.

History of present condition.—The patient has suffered from intermittent eczema since 1924. In 1930 on Sir Ernest Graham-Little's advice he was relieved by the application of 1% silver nitrate. For the last few years he has noticed a patch of white skin on the right shin which has gradually increased in size. There has been no irritation or other symptom.

On examination.—There is a large oval patch on the right shin ; approximately 5 in. × 3 in., consisting of white, thin, atrophic skin, through which the superficial subcutaneous veins can be seen. The patch is limited by a raised brown edge which shows some irregularity but no definite evidence of papules.

Complete examination reveals no sign of general illness or septic focus.

Blood Wassermann reaction negative.

Biopsy report (Professor Newcomb) : The condition appears to be of chronic inflammatory origin. The epidermis is thin and the papillæ and rete pegs are absent. Dense fibrosis of cutis with irregular destruction of elastic tissue. Patches of lymphocytes and a few foreign body giant cells apparently eating up damaged elastin.

Discussion.—Dr. MUENDE : I saw this patient eight years ago with Sir Ernest Graham-Little and the condition present then was not a dermatitis ; there was no alteration in the epidermis. What was seen was an inflammatory patch which was undergoing atrophy in the centre and that gave rise to marked thinning of the epidermis, through which the vessels were showing. We thought then it was dermatitis maculosa atrophica idiopathica, as described by Oppenheim and Finger.

Dr. G. B. DOWLING : Several years ago I presented a similar case, an oval lesion on one leg with the same atrophic waxy appearance in the centre part and brownish raised edge ; that edge showed histological changes similar to those of tuberculosis. I believe Dr. Goldsmith showed a case of the same kind a little later describing it as scleroderma with a tuberculous histology. Dr. MacCormac had described the condition before my case was shown. I believe it to be an entity.

Dr. W. J. O'DONOVAN : The patient says that he has had this lesion for fifteen years. It is outside my experience for granuloma annulare to remain in one place for fifteen years and slowly enlarge. I am not familiar with scarring or atrophy associated with what we call granuloma annulare, and I am accustomed to teach that the periphery of granuloma annulare is bordered by raised and nodose but not really altered skin, the surface pattern of the margin looks like skin. Here there is an appearance of an inflammatory reaction below the surface of the roughened skin margin. I have seen a woman with a similar appearance on both shins. I think there are more points in this case against what is ordinarily considered to be granuloma annulare.

Dr. H. MACCORMAC : In 1922 the late Dr. Stowers and I showed two similar cases at the Sectional Meeting (*Proc. Roy. Soc. Med.*, **15**, Sect. Derm., 7). They evoked a very full discussion at the time, but I do not think anybody offered a diagnosis. I agree with Dr. Dowling that the lesion is a characteristic and individual process, something which has not been described in the textbooks.

The PRESIDENT : You mean we have a new clinical entity ?

Dr. MACCORMAC : Yes, so I believe.

Case for Diagnosis. ? Phenolphthalein Eruption.—G. B. MITCHELL-HEGGS, M.D.

Mrs. M., private patient, aged 53.

Noticed coloured patches on skin under both breasts six weeks ago. Occasional irritation only. No recent illness or malaise. Always very clear skin with tendency to freckle.

Dark-haired, brown-eyed woman. No physical abnormality found. General condition : Healthy and well, only possible complaint being constipation which reacts to large doses of salts. Eighteen months ago started to take " purgoids " but has only taken about a dozen during that time. On the last two occasions, two months and two weeks ago, she took two each time. Purgoids contain phenolphthalein.

Numerous pigmented macular lesions on the under aspect of both breasts, opposing skin of chest and right flank. Not indurated or raised above level of skin. Brownish black or dark purple colour, mottled with pale centres. Several have coalesced to form a linear lesion with serpiginous edge. One small lesion is less pigmented and more pale than the others with a few telangiectases. There is also an isolated lesion on the right flank. Freckles are present on face and forearms. Seven days ago advised to obtain adequate action of bowels with vegetable laxative pill at night and mist. alba in the morning. Now no worse, possibly less marked.

21.6.39 : Advised to take two purgoids.

Dr. R. KLABER : I think pigmentary morphœa should be considered. This case bears some resemblance to one which I showed here recently when Dr. Roxburgh made that suggestion.

Dermatomyositis.—S. BEHRMAN, M.R.C.P., and L. FORMAN, F.R.C.P.

R. P., male, aged 62.

One year ago, partial gastrectomy by Mr. W. H. Ogilvie for carcinoma. Good recovery. Recurrence of gastric symptoms during the past month.

December 1938 : Began to be troubled with an irritable eruption of the face and swelling of the eyelids. Shortly afterwards a similar rash appeared in several areas on the hands and forearms, especially on the extensor aspects. Cutaneous changes of the same nature have continued to appear since then on different parts of the body.

January 1939 : Extensive loss of hair, both of scalp and eyebrows. Patient began to have difficulty in swallowing and his speech acquired a nasal character. Articulation would become very defective after saying a few words. Shortly afterwards, he first noticed an inability to abduct the left shoulder ; later a similar weakness appeared on the right side. Subsequently he noticed weakness of the legs, especially on going upstairs and on rising from a chair.

During the past month there has been a slight recovery of power in the legs ; the rash has become less conspicuous and the hair has ceased to fall out. Speech and swallowing are normal at present and he has no paræsthesiæ. He is of cachectic appearance and there is possibly some generalized wasting of the muscles. The glutei are almost completely wasted and there is considerable wasting of the supraspinati and infraspinati, especially on the left side. He shows almost complete loss of abduction at the shoulders, and considerable weakness of extension at the hip-joints. Power of other muscles not appreciably diminished. Movements of palate and face normal. No fibrillation of the muscles. No contractures. All tendon-jerks brisk ; no sensory loss.

Skin : Some irritation at night. Skin of face, particularly around orbit, has a cyanotic tinge and shows some telangiectasia and pigmentation. Back of neck scaly, pigmented, and telangiectatic. Patches of redness and scaliness on the shoulders ; some red patches on thighs, buttocks, and elbows. Section taken from side of neck where skin was red, showed some pigmentation, and was slightly thickened and quadrilated. He has recently become deeply jaundiced with white stools and bile in the urine but no pain, suggesting an obstructive jaundice, probably due to malignant glands in the portal fissure.

Report on section : The epidermis is perhaps a little thin, with one spot of parakeratosis. There is œdema of the upper half to one-third of the corium with spreading apart of the collagen bundles and also fragmentation of the fibres. There is some dilatation of the capillaries, with a spot of endothelial proliferation. With van Gieson the œdema with separation of the collagen bundles is well seen in the subpapillary layer. There is definite condensation of the connective tissue at the tips of the papillæ. The collagen bundles are crowded beneath the basal layers of the epidermis in parts. The basal layer shows rather more than normal pigmentation. There are a number of melanophores in the cutis. There is no infiltrate.

Discussion.—Dr. L. FORMAN : During the past three years I have had two other cases of dermatomyositis associated with carcinoma.

(1) A woman aged 60, who had an inoperable carcinoma of the breast, and developed erythema of the dorsal aspects of the forearms, hands and fingers, and ankles. The eruption faded after two months, leaving atrophy and pigmentation of the skin. She also had weakness of the shoulder girdle and arms muscles, but there was no mention of difficulty in swallowing.

She had had five X-ray treatments to the breast before the appearance of the rash.

(2) A woman aged 51. In July 1937 a gland was removed from the left side of the neck and was found to be a squamous-celled carcinoma. The primary source was not discovered. It was suggested that it may have been in the lower part of the oesophagus. In October 1937, she developed an erythema of the face and hands and of the ears. She had been given X-ray treatment. When I saw her in December 1937, she had weakness of the shoulder girdle and buttock muscles, difficulty in speech and in swallowing. Over the whole of the face, neck, shoulders and front of the chest the skin was erythematous, and cyanotic, particularly over the eyelids. The margins of the inflamed areas on the chest were sharply defined. The skin over the forearms and backs of the hands was red.

Subsequently she improved, the eruption largely subsided and the weakness of the shoulders improved, but her general condition deteriorated and she developed a mass in the pelvis, probably secondary deposits. A few months later she died.

Sections of the skin and of the deltoid muscle showed the changes which have been described in dermatomyositis. There was some hyperkeratosis, thinning of the epidermis, and areas of œdema of the connective tissue of the cutis with fragmentation of the collagen bundles. In the muscle there was tortuosity of the bundles, atrophy of the muscle substance and multiplication of the nuclei of the sarcolemmal sheath cells.

This association of three typical cases of dermatomyositis with carcinoma was to my mind, striking. It may of course be a coincidence. However, a superficial search of the literature showed that some four years ago, Bezecny published in *Arch. f. Dermat. u. Syph.* (1934, **171**, 223) full notes of two patients ; one had inoperable carcinoma of the breast with dermatomyositis, and the other was a more striking case who had developed skin and muscle changes six months before admission. Nine months after the onset of the dermatomyositis, ovarian tumours were removed, but secondary deposits in the peritoneum were left. A few days after the operation she was able to swallow solid food, to dress herself, and the eruption was fading. She was discharged after two weeks. Four months later, mastication and deglutition had returned to normal and the skin of the face was pale. The skin showed only scaling and occasional telangiectases and atrophy.

He gave a short note of another case of dermatomyositis and ovarian carcinoma. Eleven days after operation this case showed considerable improvement.

In all these cases I have mentioned, the skin and muscle changes, both clinical and histological (where these have been carried out) have allowed the cases to be placed in the group of dermatomyositis. The course of the skin and muscle changes in some of these cases could not be completely followed out as the patients died of carcinoma. However, in all three of my cases the skin and muscle changes showed definite improvement under observation.

For discussion I would make a tentative suggestion that as in about 50% of cases of acanthosis nigricans an association with carcinoma has been shown, so it may be that further observation will demonstrate an association between dermatomyositis and carcinoma. For my own guidance dermatomyositis occurring in an adult of mature age, would suggest particular attention to investigation of the lower abdomen for carcinoma.

In the present case, the appearance of the dermatomyositis suggests the possibility of a recurrence of the carcinoma and this was supported by the appearance during the past week of a painless obstructive jaundice.

Dr. AGNES SAVILL : In July 1935 a woman of about 58 was sent to me for vaginal discharge ; a malignant condition was found—primary epithelioma of the vagina. She was treated with radium at the Marie Curie Hospital. Four months later she came with erythema and telangiectases over the arms and recurrent urticaria of the face. There was also stiffness and weakness of the muscles of trunk and legs. Several saw her, and did not diagnose the condition ; Dr. Dowling finally suggested poikilodermatomyositis. In Guy's Hospital she was thoroughly investigated ; the tonsils were removed and she was put on glycine treatment, to which she attributed her slow recovery. But the malignant disease recurred in the uterus, and in spite of intensive X-ray she died early in 1939.

Dr. MITCHELL-HEGGS : I suggest that there is a similarity between this and the clinical picture of pellagra and that these cases of dermatomyositis associated with gastric carcinoma may be suffering from an avitaminosis apart from the dermatomyositis.

Case for Diagnosis : ? Dermatomyositis.—HUGH GORDON, M.C., M.R.C.P.

Patient, female, aged 60, has had four attacks of acute dermatitis of the face during the last eight years. On one occasion definite swelling occurred which subsided with peeling. In February 1939 she is said to have had sharp attack of influenza. Since that date she has complained of increasing weakness and loss of weight. Two months ago the present eruption appeared on the face ; there was no swelling, but considerable burning and irritation were complained of. The eruption has faded slightly in intensity but has remained more or less fixed for two months.

On examination.—A definite symmetrical erythema, with well-defined margin, is present on the face, involving the nose, supra-orbital region, and cheeks. When first seen two weeks ago it was definitely scaly and suggested the diagnosis of an acute lupus erythematosus. There is an area of telangiectatic mottling on the back of the upper arms just above both elbows. Three weeks ago there were telangiectatic scaly patches at the root of the nails and also slightly on the back of the knuckles. These have considerably faded during the patient's stay in hospital. There is obvious muscular weakness and she is unable to raise herself in bed ; the hand-grip is very weak.

A tentative diagnosis of dermatomyositis was made since nothing else appeared to account for the asthenia, loss of weight, and skin manifestations. A section taken from the arm showed practically nothing. Section of muscle taken from the triceps again showed very little abnormal. In both sections slight changes were present which were consistent with the diagnosis but not enough in themselves to establish it.

Case for Diagnosis : ? Dermatomyositis simulating Acrosclerosis.—HUGH GORDON, M.C., M.R.C.P.

The patient, a woman aged 45, has noticed a tingling in the 3rd and 4th fingers of both hands for a year. This became much worse at Christmas 1938 and she then began to notice a weakness of the hands. This weakness has progressed rapidly and the hands have become stiffened. After electrical treatment (ionization), the hands became swollen and blue : this was attributed by the patient to the electrical treatment. She was not seen at this time and the accuracy of her statement cannot be proved.

On examination a week ago there was marked wasting of all the muscles of both forearms and the interossei. The hands are beginning to assume the attitude found in acrosclerosis. The terminal phalanges have stiffened and there is a sclerodermic feeling in the back of the fingers. There are, however, no atrophic changes.

Erythematous patches can be noticed on the back of the knuckles and slightly on the front of the wrists. Examination of the central nervous system is negative. During the last week she complains of slight stiffness of the lips.

The diagnosis at first sight would probably appear to be acrosclerosis. Such well-marked muscular weakness, however, is uncommon and a diagnosis is put forward tentatively of an early dermatomyositis simulating acrosclerosis in its early stages.

Dr. P. B. MUMFORD : The patient states that of recent weeks she has tingling in the face in the morning and difficulty in moving the lips because of " stiffening ". This supports a diagnosis of dermatomyositis.

Striæ Atrophicæ. ? Dyspituitarism.—A. D. K. PETERS, M.B. (by permission of Dr. R. T. BRAIN).

L. M., a female student aged 21, complains of striæ atrophicæ and of a 1½-st. increase in weight for the last two years.

Menstrual history : $12\frac{3\cdot4}{28}$. Irregular bouts of menorrhagia treated at 19 by dilatation and curettage, and later with corpus luteum. Amenorrhœa, September 1938–January 1939. Bruises occur easily. There is solar urticaria.

On examination.—The patient is tall, 10 st. 13 lb. in weight, the obesity is most marked around the hips, abdomen, and breasts. The latter are large and tense. Broad irregular striæ are present on the buttocks, thighs, and breasts, where they are arranged in a radiating manner. They are purplish red in colour, raised, resemble wheals at first, when they are often painful, later they become paler and more depressed.

The skin is coarse and rough, seborrhœa and acne are present. Stellate nævi are seen in the face, neck, and hands, and nævi anæmici are present on the arms and legs. Numerous pigmented moles, some occurring in pairs, are symmetrically arranged on the face, back, and limbs. Dermatographism can be elicited. There is recession of hair at the temples. A small lunula is present on only one nail. The clitoris is small.

Blood-pressure : 27.9.38, 110/90 mm. Hg ; 12.6.39, 115/90 mm. Hg.

Tourniquet test negative.

Sugar tolerance test (Dr. E. C. Pillman Williams) : Values at usual half-hour intervals—

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3.10.38 : 0·11, 0·11, 0·11, 0·11, 0·09 mgm. per 100 c.c.

9. 2.39 : 0·06, 0·15, 0·11, 0·11, 0·11 mgm. per 100 c.c.

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Basal metabolic rate (Dr. Lucy Wills) : 3.10.38, 15% ; 23.5.39, 9%.

Uro-selectan test (Dr. Ulysses Williams) : 23.2.39 : Kidneys in normal position.

Skiagram of pituitary fossa (Dr. Ulysses Williams) : 10.10.38 : Definitely smaller than normal, being only 9 mm. in anterior-posterior diameter.

Blood-counts (Dr. M. Fraser) : 27.9.38 : R.B.C. 5,000,000 ; Hb. 96% ; C.I. 1 ; W.B.C. 7,350. 7.11.39 : R.B.C. 5,300,000 ; Hb. 112%. 18.4.39 : R.B.C. 5,830,000 ; Hb. 106%. 16.5.39 : R.B.C. 5,500,000 ; Hb. 100%.

Wassermann reaction negative.

Urinary excretion of hormones (Organon lab.) : October 1938 : Androgens, more than 50 comb units per litre. Œstrogens 600 mouse units per litre. February 1939 : Androgens less than 25 comb units per litre. Œstrogens 100 mouse units per litre.

Report on sections (Dr. D. M. Vaux) :

(1) Curettings from uterus, 2.11.37. Great irregularity of glands and some cystic dilatation and proliferation. The stroma shows considerable fibrosis and some infiltration with chronic inflammatory cells.

(2) Section of stria atrophica. There is thinning of surface epithelium and flattening of the papillæ. The collagenous bundles are swollen and distorted and there is œdema. The elastic tissue is altered : it is deficient in the papillary zone, and appears frayed out, thin, and fibrillary, running parallel with the surface in the subpapillary zone. In deeper layers of the corium, the elastic tissue appears as irregular somewhat frayed bundles, curled and retracted at the edges. A little perivascular lymphatic infiltration is present.

Commentary.—There are three points of interest here.

First the diagnosis of an endocrine imbalance.

Dyspituitarism would appear to be the most probable condition. The striæ, increase in weight, low basal metabolic rate, raised red cell count and recession of hair at the temples favour Cushing's basophil adenoma syndrome, but the facial expression, absence of hirsutism and low sugar tolerance are points against this diagnosis.

A low sugar tolerance, striæ, small or absent lanula of the nail, are found in Frölich's syndrome. The adrenal genital syndrome is unlikely in the absence of hirsutism and of a large clitoris and in the presence of a low excretion of male hormone and of a low sugar tolerance curve. Dr. Levy Simpson saw the case and advised an expectant attitude to both diagnosis and treatment. Miss Moore White has kindly offered to perform serial biopsies of the endometrium and it is hoped that this may afford useful information. The fluctuations of the biochemical investigations are interesting. The pituitary gland is influenced by so many factors both intrasomatic such as unbalanced diet, over exertion, anxiety, and extra somatic such as light and barometric pressure, that it is reasonable to suppose these changes to be physiological rather than pathological. These physiological fluctuations would be inclined to be more marked and possibly unbalanced during a period of endocrine instability such as adolescence.

The second point of interest is the association of striæ with endocrine dysfunction.

Increased tension of the skin is obviously of great importance, as is shown by the occurrence of striæ in conditions associated with rapid increase in the body volume, their directions along the lines of cleavage and their presence in areas where the skin is delicate.

But striæ are also found in conditions which suggest the presence of other causal factors. Thus they occur in diseases associated with loss of body volume as in typhoid, tuberculosis, Shiga-Kruse dysentery ; they are extremely variable in appearance in pregnancy and obesity, and they may appear at puberty with only a normal increase in body-weight. They are common in women, rare in men.

Brünauer found degenerative changes in the elastic tissue of the blood-vessels and in the striæ occurring in two youths who died from Shiga-Kruse dysentery and in whom the skin tension had been normal. He therefore concluded that the Shiga-Kruse bacillus produced circulating toxins with special affinity for elastic tissue. He suggested that similar elasto toxins could be produced by degenerative changes in other parts of the body and by disturbance of the endocrine system. Jadassohn has expressed this view and considers that the degenerative changes render elastin more liable to rupture when under tension.

The histological changes found in striæ have been interpreted both as being the result of mechanical rupture and also as evidence of degeneration.

The collagen is affected. Kyle believed that degeneration of collagen must always be associated with that of elastic tissue before cutaneous atrophy is clinically visible. Pinkus cates that bundles of fibres compose normal elastic tissue. Fibrillæ probably represent degenerated forms. Their arrangement parallel with the skin surface and their failure to form a supporting network for the papillæ suggest that they are no longer able to resist the tension to which they have been subjected.

Zieler suggests that the presence of fibrillæ is evidence of regeneration of elastin which seems unlikely in striæ, as Ebert has shown that while they are present in young lesions they are not seen in sections of the older, more atrophied, type. However, Gans has described the new formation of elastic fibrillæ in certain cases of diffuse scleroderma.

The swollen and distorted elastic fibres seen at the edges of the striæ are said to be present in other conditions in which there is atrophy of elastic tissue, and so can be taken as evidence of degeneration rather than of mechanical curling up after rupture. Pusey considers that where increased tension is a factor, digestive processes set up by mechanical rupture of the elastic fibres could produce the histological picture of degeneration.

Ebert in his excellent summary and histopathological study concludes that " substances

with selective toxicity for elastic tissue may be produced under some circumstances of endocrine imbalance and predispose to the production of raised striæ which later become atrophic ".

It would be interesting to examine the elastic tissue of the blood-vessels in various endocrine and toxic disorders.

The third point of interest in this case is the association of the other dermatological lesions with the endocrine imbalance.

Hæmangiomata and moles are frequent in Fröhlich's syndrome, the moles being symmetrically arranged over the face, neck, chest, and arms, and frequently occur in pairs. It is perhaps a coincidence that this is so in this case and that spider nævi are also present. Dermographism and urticaria also occur in pituitary hypoplasia.

Studies such as that of Hartman on monkeys have shown that the stair step phenomenon of successive waves of œstrogenic activity occurs during adolescence, and that there is instability as is shown by the occurrence of both irregular menstruation and of menstruation without ovulation. In humans three years has been considered to be the average time in which the menstrual cycle acquires its normal rhythm. But the total changes occurring during adolescence obviously last for a far longer period. This case is probably one of dyspituitarism of adolescence which has persisted for an unduly long time. Whether complete endocrine balance can be attained will only be shown by the future.

Dr. Parkes Weber has kindly referred me to other papers he has published and in one he suggests " that the relative insufficiency of the cutis which is a part-factor in the causation of the cutaneous striæ in so-called idiopathic and post-infectious cases may be due to a temporary basophilic hyperpituitarism associated with the period of rapid growth at and following puberty."

REFERENCES

Weber, F. Parkes (1926), " Cutaneous Striæ Purpura, High Blood-pressure, Amenorrhœa, and Obesity ", *Brit. J. Dermat.*, **38**, 1.
Id. (1932), *Urol & Cutaneous Rev.*, **36**, 731.
Ebert, M. E. (1933), " Hypertrophic Striæ Distensæ ", *Arch. Dermat. & Syph.*, **28**, 825.
Tilney, F. (1936), " The Pituitary Gland ", *Assoc. Research Nerv. & Ment. Dis., Proc.*, **17**, 3.

Discussion.—Dr. Parkes Weber : I suggest that the condition in this case is merely an extreme degree of what is commonly called " idiopathic " striæ atrophicæ of adolescence in a young woman. I admit that although these cases are called " idiopathic ", they are probably due to some relatively transitory hormonic disturbance, very likely a pituitary disturbance, so that I have no objection to the heading which Dr. Peters has given. I see that Dr. Peters mentions a paper of mine in 1926 in the *British Journal of Dermatology*, but I would point out that, amongst other differences, in my case the high blood-pressure was a very important feature, absent in the present case.

Dr. A. D. Porter : I do not think one is justified in such a case as this in saying that there is pituitary dysfunction.

Dr. Parkes Weber : These cases of " idiopathic " striæ of puberty or adolescence probably arise from some functional disturbance of the basophilic cells of the anterior lobe of the pituitary gland.[1] Because this gland happens to be apparently small in the present case it does not prove the complete absence of pituitary dysfunction.

Epidermolysis Bullosa of the Acquired Type.—H. W. Barber, M.B.

C. F., male, aged 40 ; forester.

No family history of epidermolysis. He was well until four years ago when blisters began to appear on his face, which was alone affected for a year. The eruption and accompanying changes in his skin are, I think, characteristic of epidermolysis bullosa.

When he was admitted to Guy's Hospital there were numerous bullæ, situated chiefly over the joints and at sites of pressure. Since then there has been considerable improvement, but new lesions continue to appear on the face and in the mouth.

[1] Cf. F. P. Weber, " Idiopathic Striæ Atrophicæ of Puberty ", *Lancet*, 1935 (ii), 885, 1347.

The skin of the hands, over the elbows, knees, shins, and ankles, is atrophic and " papery " in appearance. Both thumb-nails have disappeared. Milium cysts are present on the fingers.

There is no porphyrinuria and no excess of porphyrin in the stools. The Wassermann and Kahn reactions of the blood and cerebrospinal fluid are negative.

Dr. Colcott Fox in his article in Allbutt's " System of Medicine " refers to a case under his care—an adult woman who developed a bullous eruption like pemphigus but later became a typical example of epidermolysis bullosa. Fred Wise and M. F. Lautman (*Journ. Cut. Dis.*, 1915, **33**, 441) in 1915 described the case of a man aged 40 with a bullous eruption, arising at sites of trauma or friction and sometimes hæmorrhagic. It had begun fourteen months previously. The bullæ never appeared spontaneously, but arose from six to twelve hours after traumatism. Frequently after eating a meal he noticed bullæ in the mouth such as are present in my patient.

Case for Diagnosis.—G. B. Dowling, M.D.

J. W., male, aged 53. Red spots on the legs began to develop about three months ago : these multiplied rapidly and are still appearing ; they are seen chiefly on the thighs and legs, and there are several on the trunk ; each is a slightly raised red plaque measuring from about $\frac{1}{3}$ in. to $1\frac{1}{2}$ in. in diameter. The earlier lesions are

uniformly red and studded with tiny punctate " cayenne pepper " spots. The older lesions are ringed, the central part being pale yellow in colour, perhaps due to the deposition of blood pigment, while the periphery is deep red like the earlier lesions.

OCT.—DERMAT. 2*

Past history.—The patient suffered from aural vertigo three years ago and has had one or two slight recurrences. During the past two years he has passed a little blood *per urethram* from time to time ; he has been examined for this by Mr. R. H. O. B. Robinson, who reports that there is a red papilloma-like lesion in the posterior urethra.

I have brought up this case for diagnosis, because I have not seen anything like it before. Some of the older lesions have faded, leaving a yellow stain. The patient has taken no drugs other than health salts. Dr. Freudenthal has examined sections, but the histology unfortunately does not help me to make a diagnosis. He says :—

"The upper third of the cutis is œdematous and is the site of a fairly sharply demarcated infiltration. This consists of a great number of newly formed capillary vessels surrounded by lymphocytes and cells of fibroblastic type in a loose arrangement.

"The same vascular and perivascular changes are found in the middle and deeper cutis in a few places.

"The rete pegs are mostly flattened out ; some epithelial cells show vacuolation : the epithelial changes are obviously only secondary."

Discussion.—Dr. MacCormac : I thought that it was an example of Majocchi's disease.

Dr. Dowling : I think there is a difference in the lesions. In Majocchi's disease I have always understood that the spread is rather irregular and that there is a tendency to central atrophy. There is no such tendency here, the patches fading altogether without atrophy.

Note.—July 20 : The eruption is now fading rapidly.

Dr. Parkes Weber : The peculiar appearance of the lesions suggests to me that the patient has taken something either in food or in drugs which has produced the condition in question.

? Erythroplakia (Queyrat).—G. B. Dowling, M.D.

Patient, male, aged 70. For three years has had a bright red patch on the prepuce measuring about 1 cm. across, dry with soft velvety surface, which weeps occasionally, stationary for several months. I propose to have the lesion excised later on.

Shown for diagnosis.

Pigmentary Dermatosis.—H. C. Semon, M.D.

W. R., male, aged 59.

History.—Treated for pulmonary tuberculosis at University College Hospital in March 1937 with sanocrysin. He had 13 intravenous injections, one every five days, 4 grm. in all.

Three weeks after the last injection a rash appeared in the right antecubital fossa, and spread thence to the lower part of the body, eventually involving the whole integument in a severe exfoliative dermatitis. He was four months in hospital as a result, and his recovery was apparently never complete, for he was left with the lesions now present, on account of which he was first seen at the Royal Northern Hospital on March 1, 1939. These lesions consist of strictly symmetrical, dusky red, erythematous oval patches just below the tibial tuberosities of both ankles. Spreading upwards from these, and involving the skin of the lower quarter of the legs in vertical streaks are a closely aggregated collection of red-pepper-grain pigmentary spots which, it is submitted, have a very close resemblance to those described for Schamberg's dermatosis.

S. F., male, aged 24.

First attended Royal Northern Hospital in 1936 for treatment of varicose veins of left leg, with a history of a small red patch below internal malleolus for about eighteen months, i.e. first appearance five and a half years ago. It gradually spread up the leg on its inner aspect, and then appeared on the outer surface. Every few months a new patch appears and spreads rapidly. A few patches have occurred more recently in the same manner on the right leg.

The lesions when recent consist of red, scaly, irritable patches, apparently the result of aggregations of pigmented, red-pepper spots or " grains ". When quiescent, a brownish discoloration is all that remains.

The case is regarded as an example of the pigmentary disturbance loosely designated Schamberg's dermatosis, and is shown because of its striking response to X-ray treatment.

In December 1938 three doses, totalling 750 r units, were administered and the relics of the old patches are plainly visible in the form of residuary stains in which no trace of the original reddish " grains " can be recognized. Although the radiations have a therapeutic effect on the established patch, they obviously have no power to prevent relapses.

Atypical Psoriasis of Axillæ, with a Remarkable Family History of Psoriasis.—F. PARKES WEBER, M.D., and H. K. LAUBER, M.D.

O. W., female, aged 18½ years, has a large, somewhat turgid, red area in either axilla. They are said to have first appeared at the age of 4 years and to have more or less vanished during most winters, though they persisted during the whole of last winter. In spring 1938 there was also an abscess in the right axilla, doubtless due to secondary infection. There is practically no itching except during hot weather. She says that she once had a similar condition in the groins and occasionally behind the ears. At present she has a small red, scaly patch behind the right pinna, which appeared four weeks ago.

Beyond slight anæmia we have found nothing else wrong. Blood-Wassermann reaction negative. There is a remarkable family history of psoriasis. The patient's mother, who showed us psoriasis spots on her elbows and knees, told us that she had suffered from psoriasis since childhood, which used to come out during spring and disappear at the fall of the year. The mother's father, aged 84, was said to have had psoriasis " all his life ", and his mother (patient's great-grandmother), who died at about 70 years, also suffered from the disease.

Dr. W. Freudenthal's report on a piece of affected skin excised from the axilla is as follows : " Horny layer thin, mostly parakeratotic. Rete pegs considerably and regularly elongated, with corresponding lengthening of the papillæ. Some round-cell infiltration in the œdematous papillary body and in a few patches in the cutis below."

Owing to this report and the family history we feel ourselves justified in regarding the patient's dermatosis as psoriasis.

Discussion.—Dr. H. C. SEMON : One point in the history is against that diagnosis, and that is the abscess in the axillæ. Patients with psoriasis are rarely the victims of pyococcal infections.

Dr. W. FREUDENTHAL : I agree with Dr. Parkes Weber that the histological picture seen in this case could be found in an inactive phase of psoriasis. Yet in my view the evidence is not conclusive enough to settle the diagnosis on histological grounds.

The PRESIDENT : On looking at the case I should not have thought of psoriasis except for the family history. I thought these patches in the axillæ were irregular in shape, roughly

oblong. I should not have supposed that they were psoriasis, but some form of chronic inflammatory infiltration of the skin. They are rather like a nodular prurigo. But whereas a real prurigo itches almost all the time, this patient does not complain much of irritation.

Dr. PARKES WEBER: I should like suggestions as to treatment.

The PRESIDENT: I should try a dose of X-rays.

Dr. PARKES WEBER: So many different conditions react to X-rays, and we should not know from the reaction what the condition was.

Nævus Unius Lateris of the Verrucosus and Hystrix Types.—
F. PARKES WEBER, M.D., and H. K. LAUBER, M.D.

A. P., a boy, aged 7 years, was apparently normal-looking at birth. After two months the nævus began to show itself and was fully developed by the age of 1 year. The boy appears to be otherwise normal, and there is no family history of nævi, and no consanguinity between the parents.

Amongst similar cases of linear or systematized nævus verrucosus and nævus hystrix shown in London, we would only refer to J. H. Stowers, *Brit. Journ. Derm.*,
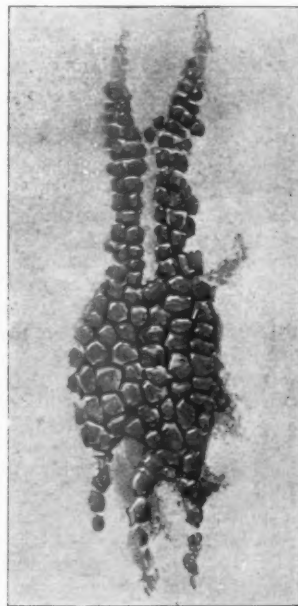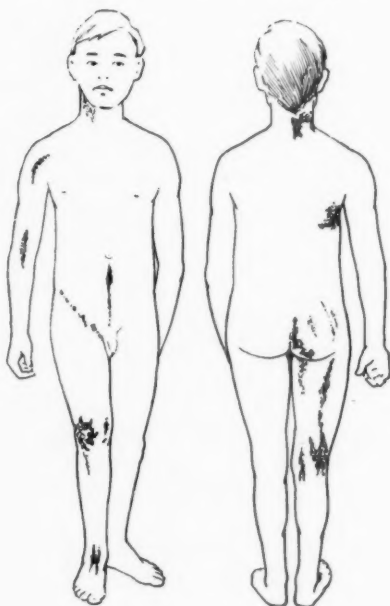
Appearance (natural size) of patch
on dorsum of right foot.

1908, **20**, 1; J. L. Bunch, *ibid.*, 1911, **23**, 273; Radcliffe-Crocker, *ibid.*, 1901, **13**, 12; F. P. Weber, *Proc. Roy. Soc. Med.*, 1911, **4**, *Sect. Dis. in Child.*, p. 32; and Dudley Corbett, *ibid.*, 1915, **8**, *Sect. Derm.*, p. 109.

In the present case the nævus, which can be termed " verrucosus " in parts, and " hystrix " in other parts, is " unius lateris "—right-sided—but, as is frequently the

case, extends just over the middle line. Indeed, the vertical verrucous line in the front of the abdomen is just to the left of the middle line. The face, hands, and soles of the feet are not affected. The exact distribution can be best shown by the accompanying diagram.

The pathological condition in cases of this kind is of course a developmental systematized dysplasia of the skin, but apparently a familial history of the condition can hardly ever be ascertained. The dysplasia seems therefore to be due not to any chromosome-abnormality in the zygote, but seems to be caused by some unknown agent which exercises its peculiar systematizing effect on the ectoderm of the fœtus during relatively early intra-uterine life.

Dr. PARKES WEBER: In this case there can be no doubt about the diagnosis, but what I want to know is whether one can treat it so as to get rid of the condition or part of the condition altogether. Fortunately it does not affect the boy's face, but the involvement of the gluteal fold is specially disagreeable.

Dr. H. C. SEMON : I think a warning should be uttered against any interference short of surgical excision and subsequent plastic repair.

Trichotillomania.—A. MURRAY STUART, F.R.C.S.

S. B., girl aged 8.

Since she was 1½ years old she has been pulling her hair out, with occasional intervals of two to three months during which she desists.

The mother states that she has noticed that the attacks usually come on when the child is tired or depressed. She does not complain of any itching. She appears to be of normal mentality. She has been under observation in St. Mary's Hospital.

Dr. James suggests that the condition may be due to *petit mal* or hysteria, including " habit spasm ". No family history of epilepsy.

Since the above, has been under observation at Child Guidance Clinic, Portsmouth. Dr. Mary Capes, the M.O. i/c, reports :—

" *Intelligence*.—She was given the Terman-Merrill and Performance Tests. Her intelligence ranks as normal, her I.Q. = 99 (average 100). On Performance Tests she was two years above her age level.

Emotionally.—She is a quiet and likeable child, amenable and affectionate. Her mother tells me that every time her father goes to sea she is very upset as she is extremely fond of him, but she is affectionate with the rest of the family too. There are occasional quarrels with the older sister but nothing exaggerated. Apart from pulling out her hair the only undesirable habit that has been noticed is that of nail-biting.

The history of pulling out of her hair is interesting in that it occurs in bouts, and during these periods, which I gather occur roughly every three months, she is more moody and reserved than when she is free from the habit."

Discussion.—Dr. H. C. SEMON : Some years ago I wrote a short report on a series of cases of trichotillomania occurring in a girls' institution, in which obviously congenital causes could be absolutely ruled out. Recognition of the fact that the girls were consciously imitating each other led to a quick cure.

The PRESIDENT : My series began with a couple of cases of ringworm in an orphanage. These two children got a good deal of attention because of their ringworm and I think the other children rather envied them and began scratching their heads. I found a number of patches where the hair had not been so much pulled out as rubbed off. I took a little time before I made up my mind as to the real cause, but ultimately I decided that these were really imitative effects. Suitable measures were taken and the thing stopped.

Dr. B. C. TATE said that these sporadic cases were essentially different from the epidemic cases described by the President and Dr. Semon. All these sporadic cases were, curiously enough, lefthanded. He had thought it possible that the condition might be in the nature of a protest against the child being forced to be righthanded, but in two recent cases the child has been allowed to remain lefthanded, so that this hypothesis would not hold.

Dr. PARKES WEBER: I regard the habit of hair-plucking in this case as exactly analogous to nail-biting. It is only one form of doing something exciting or stimulating when there is depression or ennui. It is something like smoking a cigarette when there is nothing else to be done.

Xanthomata.—A. P. NORMAN, M.B. (for Dr. R. T. BRAIN).

J. B., female, aged 14 months, has had a few yellowish nodules since the first few months of life; increasing in number recently.

Child is healthy and well nourished. The lesions are flat papules infiltrating the skin; pinkish-yellow in colour, and distributed over scalp, back, and arms. Section shows typical large foam cells of xanthoma, packed with lipoid material; some cells form syncytial masses. In paraffin, these cells have a fine reticular outline, granular cytoplasm, and small distorted nuclei. Fibrosis of skin over the xanthoma. Blood cholesterol 161 mgm.%.

Urticaria Pigmentosa.—C. H. WHITTLE, M.D.

J. S., a married woman aged 23.

The eruption has been present for two months, and occurs on the arms, legs, and trunk, chiefly on extensor surfaces. There is no sensory disturbance, and the patient feels perfectly well.

The lesions appear to consist of small areas of petechial hæmorrhages with pigmentation and probably telangiectasis. They vary in size from a pin's head to $\frac{3}{4}$ in. in diameter.

Factitious urticaria is present to a moderate degree.

Biopsy (sections shown): "There is patchy cellular infiltration in superficial layers in the dermis with some dilatation of the vessels and occasional extravasation of red cells.

The cellular exudate is mostly small round cells, there are a few polymorphs and endothelioid cells. There are no mast cells to be seen, and there is no pigmentation."

The lesions have almost disappeared during the fortnight since I saw this case and there are only relatively few lesions now left on the legs. Dermatographism was present, though is now less.

The original diagnosis is therefore in doubt owing to the rapid clearance of the lesions.

"White Spot Disease."—C. H. WHITTLE, M.D.

R. F., male aged 39, an electrician.

First noticed spots on the front of his neck a year ago. The number of spots has increased and now there is a confluent patch on the V-area in the front of neck and chest, and newer patches on the extensor aspect of the right elbow and of the forearm in the tattooed area. There is also a single spot on the left arm extensor aspect near the elbow.

He says he is otherwise well and the spots have given no trouble but some tingling

occurred in the right arm about the time the spots began to appear in this region five days ago.

They are pearly white, about 3 mm. in diameter and of fairly uniform size. On the arms they are mostly discrete, but are confluent in the neck. There is palpable thickening and visible superficial atrophic change on the surface of the affected areas. There is some scaling of the V-area but this is probably due to exposure to the sun when he wears an open-necked shirt. The arm lesions show no scaling.

Wassermann and Kahn reactions negative.

No treatment has yet been given.

There is a history of his working with radio-active substances recently, but contact was not very close, and I do not think they can be held responsible for the lesions.

Harara (Urticaria Multiformis Endemica).—F. JACOBSOHN.

B. K., male, aged 47.

The eruption has been present for about four weeks. The spots came up while the patient was in Palestine.

Showing papular urticarial eruption on legs and feet.

Arms, legs (extensor and volar aspects) show efflorescences resembling lichen urticatus. Some lesions are impetiginized. Some serous and hæmorrhagic blisters on the soles of the feet.

The disease is endemic in Palestine and occurs during the months May to November, chiefly in immigrants and children. It is caused by phlebotomus bites and is a reaction to the allergen deposited by the insect bite. The variety of lesions depends on the degree of the reaction of the individual patient. The disease may last from three to four months.

Dr. PARKES WEBER : This case somewhat looks like strophulus in children. From the description the present lesions appear to be a form of papular urticaria excited indirectly by the phlebotomus.

Section of Obstetrics and Gynæcology

President—ALECK W. BOURNE, F.R.C.S.

[*June* 16, 1939]

A Case of Mistaken Diagnosis of Malignancy in an Ovarian Cyst

By Dame A. LOUISE McILROY, M.D.

THE case is of interest owing to the diagnosis of malignancy having been made, and the resulting cure by subsequent operation.

The patient, aged 71, had noticed a gradual swelling of the abdomen, with discomfort owing to a dragging sensation but no pain. The swelling became so large she could not stoop or put on her shoes, and she suffered from breathlessness on exertion, and had to stay in bed at intervals.

In 1935 her doctor performed paracentesis and drew off $2\frac{1}{2}$ large pailfuls of green frothy fluid. Four months later $1\frac{1}{2}$ pailfuls of fluid were removed by paracentesis. Six months later she was admitted as a case of malignant disease of the abdomen with marked ascites to the Bermondsey Medical Mission Hospital. Her general condition was poor. Paracentesis was performed and repeated six months later, ten pints of fluid having been removed. On examination a large solid swelling was felt in the abdomen which was diagnosed as a malignant ovarian tumour.

Six months later the patient was readmitted to the hospital by ambulance—June 1938—suffering from severe abdominal pain with œdema of the lower limbs. I found her condition to be very poor with some emaciation and marked dyspnœa. The abdomen was tapped and five pints of greenish-brown fluid were drawn off. In July I examined her under anæsthesia and diagnosed a solid ovarian tumour but it was felt that operation was undesirable owing to the fixation of the tumour and her general condition. The abdomen was tapped again and eight pints of fluid were removed. The patient's condition showed some slight improvement, but the fluid began again to collect.

In November 1938 she was again admitted to hospital for paracentesis but her condition showed a decided improvement, although she suffered great discomfort from the enormous size of her abdomen. She was unable to lie on her back owing to the weight of the fluid ; eleven pints were removed and the abdomen was found to be filled by irregular tumours, solid in portions and cystic in other areas. The girth of the abdomen was 56 in. As her general condition had improved so much I began to doubt my diagnosis of malignancy, and suggested an operation.

In November I opened the abdomen with Miss Beatrice Turner assisting and Dr. Ealand giving the anæsthetic. There was a large multilocular ovarian cyst densely adherent to the anterior abdominal wall. It was found after separation to have its origin in the left ovary. A similar condition was found on the right side but rather smaller. Both tumours were removed after separation of dense adhesions. There was very marked distension of the stomach. About thirty pints of fluid were removed from the cysts but no free fluid was found in the abdominal cavity, and no evidence of malignancy was found at the operation. The fluid contained a considerable quantity of cholesterol and the pathological examination of the tumours reported the presence of granulosa cells with fibrous tissue and no evidence of malignancy.

OCT.—OBSTET. 1

Recovery was uneventful and she has been seen at regular intervals in the Out-Patient Department.

One may miss a diagnosis of malignancy before operation but I have not come across such a condition where the patient was kept under observation and treatment for years under the impression that the condition was too advanced for surgical interference. It is obvious that the fluid was drawn off from the adherent tumour and that secretion took place rapidly.

Utero-Abdominal Fistula in a Young Woman

By T. F. Todd, M.S.

Mrs. E. M., aged 27, was admitted as a case of acute abdomen to Crumpsall Hospital on October 11, 1937. She had been married four years without any pregnancies; there had been no gynæcological symptoms. The diagnosis of acute appendicitis was made and a laparotomy was carried out through a right paramedian incision. When the abdomen was opened a bilateral pyosalpinx was found, bilateral salpingectomy and appendicectomy were carried out and a drainage tube was left to the bottom of the pouch of Douglas for forty-eight hours. Convalescence was uneventful and she was discharged with the wound completely healed on November 6.

I saw the patient first on September 16, 1938, at Mr. Gow's request. Her story was that since leaving hospital the lower end of the abdominal wound had broken down and had been continually discharging matter for the past five months. During her periods blood had also come from the sinus. She had no other symptoms.

On examination there was a small sinus to be seen at the lower end of the paramedian incision with a little thinnish diffuse discharge but no noticeable induration. She was readmitted to Crumpsall Hospital for examination during a period on October 4, 1938, and there was obvious and profuse menstruation occurring from the lower end of the wound.

On October 8, 1938, the period had ceased and under scopolamine narcosis lipiodol was injected into the uterus and was immediately projected through the sinus at the lower end of the abdominal wound. This confirmed the diagnosis of utero-abdominal fistula. A general anæsthetic was administered and the abdomen was opened through a mid-line sub-umbilical incision. The omentum was attached to the bladder and had to be divided first and then it was seen that there was a thick tubular communication running from the right side of the fundus uteri to the lower end of the original incision. This fistula track was excised *in toto* and the uterine end was oversewn. There was a small hydrosalpinx of the uterine stump of the remaining left tube. A double loop of small intestine was attached to the uterine fundus for about $1\frac{1}{2}$ in., and the adherence was too close to warrant liberating—as a later obstruction seemed inevitable a side-to-side anastomosis was done some 8 in. above the kink. Her convalescence was uneventful, her wound healing by primary intention and she was discharged on October 25, 1938.

On January 13, 1939, the patient was re-examined; the abdominal wound had completely healed and there was no suggestion of further hæmorrhage although menstruation had occurred normally since her operation.

Comment.—The bulk of the literature dealing with utero-abdominal fistula is concerned with those following Cæsarean section, either classical operation or Porro's Cæsarean section, and I could find no report comparable to the one I present.

A case reported by Drips (1928) had utero-abdominal fistula which developed following amputation of the cervix causing a complete stenosis and a hæmatometra. Three years following the amputation of the cervix a laparotomy had been done, a

left salpingo-oophorectomy and a partial right salpingectomy were carried out. Following this operation the lower end of the wound discharged blood at regular cycles accompanied by a recognizable increase in the size of the uterus and considerable pain. The diagnosis of hæmatometra and utero-abdominal fistula was made and on further laparotomy this was seen to be due to the right tube being adherent to the previous wound. Subtotal hysterectomy and right salpingectomy resulted in a cure of the symptoms.

This case affords a further argument against salpingectomy for acute salpingitis discovered inadvertently after laparotomy for suspected appendicitis.

Reference.—DRIPS, D. G. (1928–29), *Med. Clin. of N. America*, **12**, 1579.

Mr. G. B. THOMAS : I operated upon such a case last March. The woman had had a ventro-suspension of the uterus performed a few years ago, shortly after which a small sinus had appeared in the lower part of the scar. It was very small and would barely admit the point of a fine needle, but a little blood escaped from it at the menstrual periods.

It was dealt with by opening the abdomen in the mid-line by an incision which surrounded the fistulous opening, which, together with the fistulous track, was thus left attached to the apex of the uterus. It was then removed by excision of a wedge from the fundus of the uterus, and the latter was then sutured. The abdomen was otherwise normal.

No silk or other non-absorbable material was detected in the excised tissue. Apparently at the ventro-suspension operation the needle had been passed too deeply and had entered the uterine cavity.

Pelvic Osteo-arthropathy of Pregnancy

By JAMES YOUNG, D.S.O., M.D., F.R.C.S., F.R.C.O.G.

Professor of Obstetrics and Gynæcology, University of London.

ABSTRACT.—Excessive relaxation of the pelvic joints during pregnancy has as its chief symptoms chronic backache and locomotor disturbances. Goldthwait and others have for long drawn attention to the frequent part played by softening of the sacro-iliac joint structures in the production of the common backache of pregnancy. The frequency of this symptom may be gauged by the fact that 114 women out of a successive series of 3,030 cases at the antenatal clinic, or 3·7%, suffered in such a degree as to lead them to call for treatment. In 69, or 60·5%, the pain commenced before the 28th week, whilst in the remaining 45 or 39·5%, it commenced later.

Clinical states due to joint relaxation during pregnancy (excluding coccygeal lesions) may be divided into two main groups :—

(1) Here the sacro-iliac joints are alone affected. There is no obvious lesion in the pubes and the pelvis rotates as a whole at the sacro-iliac joints. This is probably a common, possibly the chief, cause of pregnancy backache, but owing to the difficulties incidental to the diagnosis of backache with no obvious pathology, it is impossible to establish its relative incidence with any accuracy.

(2) Here the pubic joint is also affected with, as a result, a rocking of the two sides of the pelvis on the sacro-iliac joints. Here the pubic pain, the perceptible mobility of the symphysis, and X-ray examination, all help to establish a diagnosis and an estimate of incidence.

The present communication is based upon an examination of 42 such cases. 34 occurred in a successive series of 4,512 pregnant women, that is 0·75%.

These cases exhibit the same basic clinical features, namely pain and tenderness in the sacro-iliac and pubic regions coming on usually during pregnancy and aggravated by walking. Walking is often difficult, in severe cases impossible, and there is frequently a waddling gait, the characters of which are shown in the moving picture of 5 cases.

The ætiology and treatment are discussed.

Résumé.—Les symptomes principaux du relâchement excessif des articulations pelviennes pendant la grossesse sont des douleurs lombaires chroniques et des troubles de la démarche. Goldthwait entre autres a depuis longtemps attiré l'attention sur le rôle fréquent du ramollissement des structures articulaires sacro-iliaques dans la production des douleurs lombaires fréquentes de la grossesse. La fréquence de ce symptome peut être estimée par le fait que dans une série de 3,030 cas consécutifs observés à la clinique anté-natale 114, ou 3·7% souffraient suffisament pour réclamer un traitement. Chez 69, ou 60·5%, les douleurs ont commencé avant la 28e semaine, tandis que chez les 45 autres, ou 39·5%, elles ont commencé plus tard.

Les états cliniques dus au relâchement des articulations pendant la grossesse (sans compter les lésions coccygéales) peuvent être divisées en deux groupes principaux :

(1) Les articulations sacro-iliaques seules sont affectées. Il n'y a pas de lésion évidente au pubis et le bassin tourne en une pièce sur les articulations sacro-iliaques. Ceci est probablement une cause fréquente, peut-être la cause principale, des douleurs lombaires pendant la grossesse, mais comme il est difficile de diagnostiquer les douleurs lombaires dans l'absence de pathologie évidente, il est impossible d'en établir la fréquence relative avec exactitude.

(2) La symphyse est aussi affectée. Par conséquent les deux côtés du bassin se balancent sur les articulations sacro-iliaques. Dans ce cas les douleurs pubiques, la mobilité perceptible de la symphyse et l'examen radiologique aident à établir le diagnostic et à estimer l'incidence des cas.

Cet ouvrage est basé sur l'examen de 42 cas de cette espèce. 34 ont été trouvés dans une série consécutive de 4,512 femmes gravides, ce qui donne une fréquence de 0·75%.

Tous ces cas avaient les mêmes symptomes cliniques fondamentaux, c'est-à-dire des douleurs et de la sensibilité dans les régions sacro-iliaque et pubique, commençant généralement pendant la grossesse, et aggravées par la marche. La marche est souvent difficile, quelquefois impossible, et la démarche est souvent dandinante. Les caractères de la démarche sont démontrés par un film illustrant 5 cas.

Discussion de l'étiologie et du traitement.

ZUSAMMENFASSUNG.—Goldthwait und andere haben schon seit langem darauf hingewiesen, wie häufig die Erweichung der Sakroilialgelenke bei der Entstehung der so häufigen Rückenschmerzen bei der Schwangerschaft eine erhebliche Rolle spielt. Wie häufig dieses Symptom ist geht aus der Tatsache hervor, dass von 3,030 auf der pränatalen Klinik beobachteten Fällen bei nicht weniger als 114 (3·7%) die Beschwerden so stark waren, dass Behandlung notwendig wurde. Bei 69 (60·5%) begannen die Schmerzen vor der 28 Woche, bei den restlichen 45 (39·5%) zu einem späteren Zeitpunkt.

Die durch die während der Schwangerschaft eintretende Gelenkerweichung verursachten klinischen Zustände (abgesehen von coccygealen Läsionen) kann man in zwei Hauptgruppen einteilen :—

(1) Die Veränderungen betreffen auschliesslich die Sakroilialgelenke. Es bestehen keine nachweisbaren Veränderungen an den Schambeinen und das Becken rotiert als Ganzes um die Sakroilialgelenke. Dieser Zustand ist wahrscheinlich eine häufige, möglicherweise die hauptsächliche Ursache der Schwangerschaftrückenschmerzen; da aber mangels einer nachweisbaren pathologischen Veränderung die Diagnose schwierig ist, ist es unmöglich irgendwelche genaueren Angaben über die relative Häufigkeit zu machen.

(2) Die Symphyse ist mitbetroffen; dementsprechend führen die beiden Seiten des Beckens eine Schaukelbewegung um die Sakroilialgelenke aus. In diesen Fällen ermöglicht der in der Gegend der Schambeine lokalisierte Schmerz, die nachweisbare Beweglichkeit der Symphyse und die Röntgenuntersuchung die Diagnose zu stellen und ein Urteil über die Häufigkeit des Zustandes zu gewinnen.

Der vorliegenden Mitteilung liegen die Befunde bei 42 solcher Fälle zugrunde. 34 wurden in einer lückenlosen Serie von 4,512 Schwangeren beobachtet, d.h. in 0·75%.

Alle diese Fälle zeigen grundsätzlich die gleichen klinischen Erscheinungen, nämlich Schmerzen und Druckempfindlichkeit in der Gegend der Sakroilialgelenke und der Pubes, die gewöhnlich während der Schwangerschaft auftreten und durch Gehen verschlimmert werden. Das Gehen ist oft erschwert, in schweren Fällen sogar unmöglich, und häufig besteht ein watschelnder Gang, dessen Charakteristika in einem Film (Beobachtung an 5 Fällen) illustriert werden.

Die Aetiologie und Behandlung werden besprochen.

From ancient times it has been known that during pregnancy there occurs a softening of the structures of the pelvic joints and that this results in the acquisition by these joints of a degree of movement which they do not ordinarily possess. Within recent years these changes have been studied by means of X-rays. Heyman and Lundqvist (1932) as a result of the examination of 74 pregnant women and eight women during labour, concluded that pregnancy is invariably accompanied by an increase in the width of the symphysis pubis. This increase, which averages 2 mm., varies between 1 mm. and 12 mm. in different women. It commences in the early months and probably reaches its maximum two or three months before labour. There is no increase during labour and within several weeks after labour the pubic joint has returned to its previous state. Roberts (1934) at a meeting of this Section in 1934 reported similar findings and he showed also that there occurs a slight measurable widening of the sacro-iliac joints which again disappears soon after parturition. Abramson, Roberts and Wilson (1934) and others have published similar results and in their paper they allude to the clinical states which may arise from excessive relaxation of the pelvic joints during pregnancy.

From time to time in the literature records have appeared of excessive separation of the pelvic joints, more especially of subluxation of the symphysis pubis. I am probably correct in stating that to most obstetricians the subject has been more of academic than of practical interest unless they have seen a case exemplifying the somewhat rare major degrees of damage.

My first contact with the condition was a woman whom I confined about twenty years ago. Immediately after the delivery she complained of severe pain and tenderness at the pubic joint. Despite complete rest in bed the condition persisted and movement was so painful that she was unable to get out of bed at the end of fourteen days. As it was imperative for her to sail to South Africa without delay she had to travel to the ship by ambulance. The next case of which I have records, occurred some twelve years later. Mrs. A., aged 27, was first seen two months after her first birth. Since the birth she had difficulty in walking, with pain round the pelvic girdle and marked tenderness at the region of the pubes and both sacro-iliac joints. There was a marked waddle in the gait and pain and tenderness located over the adductor muscles of the thigh on each side. X-ray examination revealed a wide separation at the symphysis pubis. Rest in bed with firm strapping of the pelvis led to a quick subsidence of the pain and tenderness and recovery of the locomotor functions. A year later this patient became pregnant again, and, at the fourth month, the symptoms, pain over the pubes and limping gait, recurred. On this occasion there was also severe pain in the back with tenderness over both sacro-iliac joints. By the thirty-second week the symptoms were so grave that the patient was unable to stand or walk. Despite complete rest in bed, dietetic measures and support of the pelvis by means of strapping, the pain persisted, and any movement, such as that required in the use of the bedpan produced severe pain in the pubic and sacro-iliac regions. Having regard to the experience following the previous birth Cæsarean section followed by sterilization was carried out on October 2, 1932. Thereafter, by the use of the appropriate measures, rest, massage, immobilization of the pelvis with strapping and a firm surgical belt, a satisfactory recovery was established within three months. In parenthesis I would state that, with greater experience we find that, even in such aggravated cases, Cæsarean section is not necessary. With adequate care during the pre-natal and post-natal periods good recovery can generally be expected even after pelvic delivery.

The next case was even more striking in its clinical features. Mrs. H., aged 30, had her first birth in 1928. The delivery was normal and spontaneous and the child, 8½ lb. in weight, was alive and well. In 1932, at the end of the sixth month of the second pregnancy, in getting out of her car she felt that something was wrenched and she was seized with sudden pain in the lower abdomen. She had difficulty in walking the few steps to her house and thereafter she remained for five days in bed.

On getting up she experienced difficulty in walking and felt pain on the outer side of the right thigh and in the lower abdomen. When seen three weeks later she was unable to stand without severe pain in the pelvis and walking was associated with a waddling gait. There was marked tenderness over the symphysis pubis. X-ray examination showed the pubic bones to be unduly separated and this was associated and probably determined by a tearing loose of the surface of bone underlying the right aspect of the joint. When standing alternately first on one foot and then on the other there was found to be an upward gliding movement of the corresponding side of the pelvis. This case exemplifies a finding which I have seen repeated in a number of subsequent cases, the dating of the symptoms from a comparatively trivial trauma, such as a strain or fall, suggesting that the weakening of the joint structures exposes them to easy damage. Another point which is raised by this case is that the weakening process may affect the bony tissue and that we are not necessarily dealing merely with a change in the softer joint elements.

Since having the cases just described I have seen several further examples of severe pubic and sacro-iliac damage in relation to pregnancy. But I wish now to draw attention to the fact that these somewhat dramatic instances of this lesion constitute merely the rarer manifestations of a state which is by no means uncommon in a milder and easily neglected form.

The clinical states which owe their origin to joint relaxation during pregnancy (excluding coccygeal lesions) may be divided into two main groups :—

(1) Here the symptoms are restricted to the sacro-iliac region. There is no clinical evidence of a pubic lesion and the pelvis remains compact, the pain and locomotor disturbance being explained by an excessive rotation of the whole pelvis at the sacro-iliac joints. This is a common, possibly the chief, cause of the frequent pregnancy backache as Goldthwait (1907) and others have contended. Dr. Hannah Elder at the Ante-natal Clinic of the Edinburgh Royal Maternity and Simpson Memorial Hospital found 114 women out of a successive series of 3,030 cases, or 3·7%, who suffered in such a severe degree during their pregnancy as to lead them to call for treatment. At the same time, the diagnosis in this class of backache, which ordinarily possesses no pathology that can be recognized by X-rays or other means, being notoriously difficult, it is impossible to establish with accuracy the relative incidence of the above factors.

(2) In the second group the relaxation of the pubic joint is associated with localizing symptoms. Here the change results in a loosening of the two sides of the pelvis, which rock separately at the corresponding sacro-iliac joint. Pubic pain and tenderness, perceptible mobility of the symphysis and X-ray examination all help to establish a diagnosis and thus a reliable estimate of incidence.

The present communication is based upon an examination of 42 such cases 34 occurred in a successive series of 4,512 pregnant women, that is 0·75%. This may be taken to represent the minimal incidence of the combined pubic and sacro-iliac lesion for it is found that the more carefully cases of pregnancy backache are studied the more frequently does one find an associated pubic picture. Naturally it is the milder cases which are liable to be overlooked.

PUBO-SACRO-ILIAC OSTEO-ARTHROPATHY

Clinical features.—These cases exhibit the same basic clinical features, namely, pain and tenderness in the sacro-iliac and pubic regions coming on usually during pregnancy and aggravated by walking. Walking is often difficult, and, in severe cases, impossible and there is frequently a limp or waddle in the gait. (The characters of this gait were exemplified by a moving picture of five cases exhibited by Professor Young.) In some cases the pain and tenderness are located to one, in others to both, sacro-iliac joints. In cases exhibiting severe locomotor difficulty there is often pain

and tenderness along the line of the adductor muscles of the thigh, which probably arise from stretching of these muscles as during walking the side of the pelvis containing their attachment is displaced forcibly upwards. In a considerable number of cases the patient dates the symptoms abruptly to some trauma, which may be trivial, such as a slip or fall. In one instance the bending down to tie a shoe-lace was immediately followed by acute symptoms. This point I shall raise again.

In 34 cases there are records of the time of first onset of symptoms. In one case these first appeared ten days post-partum after the patient had got out of bed. In the remaining 30 the condition arose during pregnancy. The average date of onset was the twenty-fourth week of pregnancy, the earliest date being eight weeks, the latest thirty-six weeks. 14 cases were primigravidæ—in these the average date of onset was 25·7 weeks. 14 were paræ and in these the average date of onset was 22·8 weeks.

Changes in the joints and a consideration of ætiology.—No attempt was made in this investigation to carry out an exact measure of the width of the joints but we have been impressed by the fact that the severity of the symptoms does not bear, as other workers have suggested, any correlation with the increase in pubic separation. On this matter our evidence is convincing in that many cases with severe symptoms
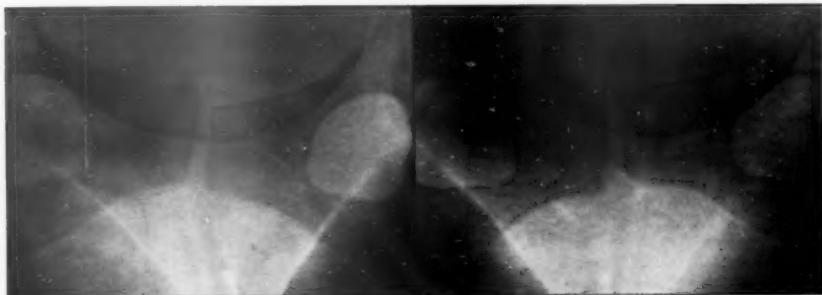

Fig. 1.—Gliding movement at symphysis pubis. Patient standing on right leg. Pregnancy thirty-nine weeks.   Fig. 2.—Same patient standing on left leg.

exhibit no greater widening than is found ordinarily in pregnant women with no symptoms related to the pelvic girdle. At the same time where pubic symptoms are severe one can usually easily detect a gliding movement at the joint when the joint is grasped between one finger in the vagina and the thumb over the symphysis and the patient is requested to stand first on one foot and then on the other. Further in such cases there is radiographic evidence of such movement at the joint (figs. 1 and 2). We may assume, therefore, that the degree of softening and mobilization of the joints is not necessarily exhibited in the extent of the widening. From time to time, however, we do find a considerable widening of the pubic joint, but here again the gravity of the symptoms is not necessarily proportional to the degree of this widening.

The major consideration in ætiology is why a condition which must be regarded as essentially physiological should in a certain number of women pass over into the morbid. The role of trauma has been mentioned. In 5 out of 34 there was a definite causal relationship between an accident, usually minor in nature, and the onset of the symptoms.

It would seem to be clear that the tone of the muscles supporting the joints must sometimes play a part and that where this tone is lowered damage of relaxed joints must be more liable to occur. It may be significant in this connexion that 15 out of

the 34 women, or 44·1%, suffered from such associated conditions as toxæmia and pyelitis. The altered posture adopted during pregnancy may also play some part. The gradual enlargement of the womb and the passing forward of the centre of gravity results in the woman throwing the shoulders farther and farther back in order to readjust the body balance during standing and walking. This alteration in the spinal curves with a consequent transmission of the body-weight along new lines has been adduced as a cause of lumbosacral backache by creating stresses and strains in the corresponding joints and muscles. Finally, as it is now generally assumed that the relaxation of the pelvic joints during pregnancy has an endocrinal origin, the essential ætiology may eventually be found in some aberration of this function.

Treatment.—In mild cases the provision of a strong abdomino-pelvic belt and restricted exercise are sufficient to carry the patient through to delivery. In worst cases rest in bed for a period varying in different cases from one to three weeks, may so relieve the symptoms as to make walking comfortable with the support of a belt. In the worst type of case complete rest in bed till delivery is called for. In such the hammock as used for the treatment of fractured pelvis is of great value. In these women the gentlest movement in bed is not tolerated, e.g. the placing of a bedpan.

After delivery the extent to which special treatment is required varies with the case. In mild cases the symptoms have disappeared by the end of the ordinary lying-in period. In severer cases a longer rest in bed, it may be for as long as two or three weeks, is necessary and then a strong supporting belt should be worn for several months. In the worst type the hammock régime should be continued for at least a month after delivery. In some cases immobilization may be necessary for several months.

REFERENCES

ABRAMSON, D., ROBERTS, S. M., and WILSON, P. D. (1934), *Surg., Gynec., & Obst.*, **58**, 595.
GOLDTHWAIT, J. E. (1907), *J. A. M. A.*, **49**, 768.
HEYMAN, J., and LUNDQVIST, A. (1932), *Acta obst. et Gynec., Scandinav.*, **12**, 191.
ROBERTS, R. E. (1934), *Proc. Roy. Soc. Med.*, **27**, 1217 (Obst. and Gynec., 51).

Discussion.—Mr. C. J. K. HAMILTON : I would like to ask Professor Young if he considers that the tilting of the pelvis is a permanent or temporary matter. Recently we have X-rayed the pelves of patients who have been X-rayed previously during pregnancy and we have found that the tilt of the pelvic brim remains the same, some time after delivery.

Recently I have seen several X-ray pictures showing a thin black line in the middle of the symphysis. Dr. Rubin tells me that he considers that this must be due to air or a vacuum. He has also noticed the same appearance in some traumatic lesions of the knee and shoulder joints. The appearance in the symphysis disappears soon after delivery.

Mr. R. NICHOL said that the question as to how much this relaxation of the pelvic joints was due to an endocrine influence, and how much to some calcium deficiency was of interest.

He thought that a glance at comparative anatomy might shed some light on this question and referred to the relaxation of the pelvic joints of the seal during pregnancy ; he said that it was known that at parturition in this animal the symphysis pubis separated for several inches. Also it was known that the guinea-pig's pelvis is so small that delivery would be impossible but for a wide separation at the symphysis pubis during labour. If nature provided for such a degree of movement in these animals in their normal state, it did not seem to him that calcium deficiency was a necessary component of the mechanism.

Mr. Nichol then referred to Professor Young's mention of the part played by trauma in the ætiology of the condition which he had called pelvic osteo-arthropathy. Some years ago, when called out to assist a midwife, he had applied forceps to a fœtal head which had been arrested in its passage through a rather small pelvis. On applying moderately strong axis traction he suddenly heard a crack and the fœtal head thereupon easily came down and was delivered. On examining the pubic synchondrosis he found a space which allowed his finger to drop in, and later an X-ray showed a wide separation of the bones. Fortunately there had been no

damage to the soft parts, and after a prolonged rest with the pelvis tightly strapped the patient made a good recovery.

Professor YOUNG (in reply) stated that he had not had the opportunity of studying the question raised by Mr. Hamilton in an adequate series. In individual cases with marked rocking of the two sides of the pelvis during pregnancy he had, however, found a slight degree still present at the end of two or three weeks after labour.

The Effect of the Inclination of the Pelvic Brim and the Shape and Inclination of the Upper Sacrum on the Passage of the Head through the Upper Pelvis

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ABSTRACT.—Engagement of the head does not depend only on the size and shape of the brim, but also on the angle of inclination of the brim. The methods of determining this inclination are considered and the angle between the plane of the brim and the front of the body of the 5th lumbar vertebra is found to furnish the best index of the inclination. Analysis of a series of cases shows that this angle varies considerably. Its postural range is demonstrated.

When the inclination is high the head does not easily engage although the measurements may be normal, and a high inclination is one of the commonest causes of unexpected dystocia.

Because these cases are usually selected for a " trial of labour ", criteria are necessary to select the cases suitable. Success or failure of trial labour in these cases depends on the amount of room in the upper pelvis. Apart from the actual size of the true conjugate the amount of room is shown to depend both on the sacral inclination, a method of measuring which is described, and the shape of the upper sacrum, which shows considerable variation. A common type of pelvis causing dystocia is one in which the inclination of the brim is high and the upper sacrum is relatively vertical and convex. Pelves of this type do not always fit into any of the standard classifications.

The uses and limitations of postural treatment of these cases are discussed.

RÉSUMÉ.—L'engagement de la tête dépend non seulement de la grandeur et de la forme de la marge du bassin, mais aussi de son inclinaison. Après avoir considéré les méthodes pour déterminer cette inclinaison, les auteurs concluent que le meilleur index est donné par l'angle entre le bord antérieur de la cinquième vertèbre lombaire et le plan de la marge du bassin. L'analyse d'une série de cas montre que cet angle est très variable. Les limites de sa variation avec la position sont démontrées.

Quand l'inclinaison est considérable la tête ne s'engage pas facilement même si les dimensions sont normales, et une grande inclinaison est une des causes les plus fréquentes d'une dystocie inattendue.

Comme ces cas sont généralement choisis pour une " épreuve de travail ", des critériums sont nécessaires pour aider à la sélection des cas appropriés. Le succès ou non de l'épreuve de travail dans ces cas dépend de l'espace dans le bassin supérieur. Les auteurs démontrent que cet espace dépend non seulement de la grandeur du conjugué vrai, mais aussi de l'inclinaison du sacrum, qui est très variable, et décrivent une méthode pour la mesurer. Un type de bassin qui cause souvent une dystocie a une marge très inclinée et un sacrum relativement vertical et convexe. Les bassins de ce type ne peuvent pas toujours être placés dans une des catégories classiques.

L'utilité et les limitations du traitement postural de ces cas sont discutées.

ZUSAMMENFASSUNG.—Die Einstellung des Kopfes hängt nicht nur von der Grösse und Form des des Beckeneinganges ab, sondern auch von seinem Neigungswinkel. Verff. diskutieren die verschiedenen Methoden zur Bestimmung dieses Winkels und kommen zu dem Ergebnis, dass der Winkel zwischen der Beckeneingangsebene und der Vorderseite des 5. Lendenwirbelkörpers den besten Anhaltspunkt zur Bestimmung dieses Winkels abgibt. Die Analyse einer Reihe von Fällen

zeigt, dass dieser Winkel grosse Verschiedenheiten aufweist.   Seine Veränderungen mit der Körperstellung werden aufgezeigt.

Wenn die Neigung erheblich ist stellt sich auch bei normalen Grössenverhältnissen der Kopf nur schwer ein ; eine starke Neigung der Beckeneingangsebene stellt eine der häufigsten Ursachen von unerwarteter Dystokie dar.

Da man sich bei Fällen dieser Art meist dafür entscheidet zunächst einen normalen Geburtsverlauf abzuwarten, müssen Kriterien zur Auswahl geeigneter Fälle aufgestellt werden. Ob ein normaler Geburtsverlauf eintritt oder nicht hängt von der Geräumigkeit des oberen Beckens ab.   Die Grösse des Raumes hängt abgesehen von der tatsächlichen Grösse der Conjugata vera von der Neigung des Sakrums ab—eine Methode zu deren Messung wird beschrieben—ferner von der Form des oberen Teiles des Kreuzbeines, die erhebliche Variationen aufweist.   Eine Beckenform, die häufig zur Dystokie führt, ist jene, bei welcher die Neigung des Beckeneinganges hoch und der obere Teil des Kreuzbeines relativ senkrecht und convex ist.   Becken dieser Art lassen sich nicht immer in eine der klassichen Gruppen einreihen.

Die Behandlung dieser Fälle mittels Lagerung, und die Beschränkungen dieser Methode werden besprochen.

THE present investigation was undertaken in the first place to determine the significance in obstetric practice of variations in the inclination of the pelvic brim, but an examination of the data which were collected made it evident that the other factors which determine the passage of the fœtal head into and through the upper pelvis would have to be considered along with the pelvic inclination, and the inquiry resolved itself into a more general investigation of the causes of high dystocia in women whose pelvic measurements are normal.

The engagement of the fœtal head and its descent into the pelvic cavity depend on the following mechanical factors :—

I   The shape and size of the pelvic brim.
II   The shape and size of the presenting part.
III   The inclination of the pelvic brim.
IV   The shape of the upper sacrum.
V   The inclination of the upper sacrum.

(1) *The Inclination of the Pelvic Brim*

(a) *Measurement of the angle of inclination.*—There are two methods by which the angle of the brim may be measured.   The older method is to determine the angle between the pelvic brim and a horizontal plane.   This, in effect, was the only method available before the development of radiological methods.   It has been used by some workers, notably Mackenzie in 1923, who described a radiological method of measuring the angle of the brim with the horizontal and found its average value was 60°.

It has, however, two disadvantages.   In the first place it is of little use for comparative purposes because the angle is measured against an arbitrary plane situated outside the patient.   The second objection is that it takes no account of the curve of the lumbar vertebræ, upon which the obstetrical importance of the inclination of the pelvic brim will be shown to depend.

In view of these objections to the conventional method of measuring the angle of inclination of the brim, Dr. R. E. Roberts suggested measuring the angle formed by the plane of the brim and the front of the body of the 5th lumbar vertebra. This method answers the two objections raised against the older one.   In the first place all the data for measuring the angle are present on the film and no reference is necessary to any arbitrary plane outside the patient.

The second and more important advantage is that it does take cognizance of the line of the lower lumbar spine.   This point may be rendered more clear if consideration is given to the features of the pelvic brim of the anthropoid pelvis.   In the gorilla, for instance, the pelvic brim forms nearly a vertical angle with the horizontal plane and the pelvic inlet looks almost backwards.   This high inclination of the brim to

the horizontal is offset, however, by the forward crouch of the lumbar spine, which reduces the angle between the brim and the front of the 5th lumbar vertebra to 100°. Measured against a horizontal plane the inclination of the brim is high, measured by the second method against the body of the 5th lumbar vertebra the angle is low. In other words, in the anthropoid pelvis the angle between the brim and the lumbar spine permits full correspondence between the axes of the uterus and the brim despite the high inclination of the brim to the horizontal. One might call the angle between the brim and the body of the 5th lumbar vertebra the *obstetric inclination* of the pelvis, and the angle of the brim with the horizontal the *postural inclination* of the pelvis.

This angle can only be measured accurately by an X-ray method, although a rough estimation of the pelvic inclination may be made by noting the direction of the external conjugate, which, as Newmann and Ehrenfest (1900) have shown, closely follows the line of the pelvic brim. The objection to clinical methods is that they only allow the inclination to be measured against the horizontal, i.e. they only measure the postural inclination of the pelvis, although a high obstetric inclination may be suspected when undue inclination of the external conjugate is noted in conjunction with a flattening of the normal lumbar curve. We have made a few determinations of the inclination with an inclinometer, but found the results were too variable to be of any use for comparative purposes.

The increased lordosis of some pregnancies indicates a postural compensation for an abnormally high obstetric inclination of the pelvis. To apply an abdominal binder in such a case because the abdomen is pendulous is not good practice because it interferes with this compensatory adaptation.

(b) *The obstetrical importance of the pelvic inclination.*—Before the development of radiological pelvimetry, variations in the pelvic inclination were mainly of anthropological interest. Scheyer (1932), for instance, found the inclination lower in Japanese than in Europeans. In obstetrics, on the other hand, little interest was taken in the importance of any variations. Whitridge Williams, for instance, stated in the 1924 edition of his textbook that the pelvic inclination possesses no practical obstetrical significance, and Reed and Serbin, writing in Curtis' textbook in 1934, state that the normal inclination of the brim is a problem which has never been satisfactorily solved.

Thoms (1935) states that the angle of inclination of the brim is higher in the type of pelvis he designates " anthropoid ".

More recently, in 1936, Garret and Jacob published an important paper on the obstetrical significance of variations in the pelvic inclination. Jacob (1934) put the matter very clearly : " As the plane of the inlet approaches the spinal column the faculty of engagement diminishes ; as it becomes perpendicular to the spinal column the superior strait is placed in the path of the forces of expulsion and engagement of the head."

A further reference was made to the subject by Theobald (1936) in a discussion at the Royal Society of Medicine in 1936 on the Value of the Induction of Labour in Primigravidæ, where he stated that in his opinion undue inclination of the inlet is present in many cases which are selected for a trial labour because of non-engagement of the head.

More recently, in 1936, one of us (P. M.) published a paper showing the influence of the angle of inclination of the brim on the engagement of the head and the possibility of postural treatment as a means of correcting a fault in this angle. The paper was based on a short series of cases in which the angle was measured by the method advised by Dr. R. E. Roberts.

As a first step it was necessary to establish the value of the normal angle of inclination of the pelvic brim by the method advocated by Dr. Roberts. Dr. Whitaker was kind enough to take a series of lateral films in 25 normal pregnant women nearing term. The figures he obtained are as follows :—

In four cases the angle was between 120° and 125°, in two cases between 126°

and 130°, in five cases between 131° and 135°, in eight cases between 136° and 140°, in two cases between 141° and 145°, in two cases between 146° and 150°, in the remaining two cases the angle was 151°. The average value of the angle was 136°.

In order to determine whether a fallacious reading of the angle is obtained if the radiograph is not taken in a true lateral position, we measured the angle in a few cases with the patient lying askew. No appreciable difference was noticed in the size of the angle.

(c) *Variation with posture.*—The next step was to determine how much the inclination of the brim is modified by posture in normal women.

TABLE I.—VARIATION IN THE ANGLE OF INCLINATION OF THE BRIM
IN NINE NORMAL PREGNANT WOMEN.

No.	Angle of pelvic inclination		Range
	Legs extended	Legs flexed	
1	133°	138°	5°
2	143°	132°	11°
3	140°	137°	3°
4	136°	129°	7°
5	134°	139°	5°
6	127°	118°	9°
7	146°	134°	12°
8	149°	130°	19°
9	120°	110°	10°

It will be seen that adoption of a flexed position diminishes the angle of inclination of the brim by a variable amount, between 3° and 19°.

We also had the postural range measured in five non-pregnant women and as was to be expected found it greater than in pregnant women, full flexion of the legs being impossible when a pregnancy is near term. The range of movement was 14°, 14°, 12°, 16°, 25°, in these five patients.

To decide the point whether a high inclination in an adult is a persistent adolescent feature, Dr. Rubin X-rayed a few adolescent boys and girls. In the pelvis of the fœtus and a child the angle of the brim is very high, and it is evident that the lower angle of inclination of the adult is due to the development of the secondary lumbo-sacral curves of maturity. The six measurements made in adolescents were found to be 119°, 139°, 149°, 139°, 122°, 129°, giving an average of 135°. This shows that a high inclination cannot be considered as a persistent adolescent character. Whether high inclination is a persistent infantile character we have not enough evidence to decide.

The two other pelvic characteristics under consideration are the sacral inclination and the shape of the upper sacrum.

(2a) *The Inclination of the Sacrum.*

It is clear that the amount of room available in the pelvis immediately below the brim depends partly on the inclination of the upper sacrum, and the results did show that the success or failure of trial labour in a patient with a high inclination of the brim is intimately related to this characteristic of the pelvis.

Meyer's (1873) approach to this problem was to regard the 3rd sacral vertebra as a fixed point, and he constructed a diameter extending from the upper margin of the symphysis to the middle of the 3rd sacral vertebra which he designated as " the normal conjugate ". We elected to measure the inclination of the sacrum by measuring an angle, because looking at the problem from Meyer's point of view there is no limit to the number of conjugates that could be measured.

The angle selected for this purpose is that formed by the plane of the brim and the front of the 1st sacral vertebra, an angle which may conveniently be designated " *the sacral angle* ". Measurement of this angle gives an estimate of the amount of room available in the upper part of the cavity.

We found that a correspondence exists between the angle of inclination of the pelvic brim and the sacral angle and that for a specific inclination of the brim there is a corresponding average sacral angle.

TABLE II.

Angle of inclination of the brim	Average sacral angle
160°–170°	71°
150°–159°	84°
140°–149°	87°
130°–139°	96°
120°–129°	109°

(2*b*) *The Postural Range of the Sacral Angle.*

The adoption of the flexed posture increases the alignment of the lumbar vertebræ and the sacrum, so that the sacrum becomes more vertical and the sacral angle is diminished. Posture, however, has much less effect upon the sacral angle than it has upon the inclination of the brim. In seven cases we found the range of the sacral angle between extension and full flexion was 3°, 5°, 7°, 3°, 5°. In two of the cases, however, the angle increased by 2° and 3° respectively, i.e. the sacrum became slightly more horizontal. The greater postural range of the inclination of the brim is due to the greater mobility of the lumbosacral joint as compared with that of the sacro-iliac joints.

(3) *The Shape of the Upper Sacrum.*

The third pelvic characteristic under investigation is the shape of the upper sacrum. It is clear that the upper sacral shape along with the sacral inclination conditions the amount of room available for the head in the upper pelvis.

The shape of the upper sacrum varies considerably. For practical purposes it is sufficient to classify the contour formed by the front of the upper two sacral vertebræ as one of three groups, convex, straight, and curved. Both convex and straight sacra occur very much more commonly than we expected, particularly in pelves in which the angle of inclination of the brim is high, as shown in the following table :—

TABLE III.

Angle of inclination of the brim	Type of sacrum		
	Convex	Straight	Curved
160°–170° ..	4 cases	3 cases	1 case
150°–159° ..	8 cases	5 cases	0
140°–149° ..	8 cases	13 cases	9 cases
130°–139° ..	3 cases	0	7 cases
120°–129° ..	0	1 case	7 cases

The table does seem to establish the fact that the more normal the inclination of the pelvic brim the more likely is the sacrum to have a normal curve.

It is clear that the convex type of sacrum must give rise to certain difficulties in the upper pelvis because the convexity forms a false promontory and this increases the depth of the brim through which the head has to pass, and to a lesser extent a straight sacrum also diminishes the amount of room in the upper pelvis. A high sacral angle of course will tend to offset any abnormality of the upper sacrum.

CLINICAL DATA

The investigation was based on 69 cases in which we were able to obtain complete clinical and radiological data. The cases were not specially selected for the present investigation. Most of them were investigated because of apparent disproportion, delay in labour or difficult forceps delivery. Some normal cases were included for comparative purposes.

As the investigation was primarily undertaken to decide the importance of variations in the angle of inclination of the brim, the cases were first divided into groups according to this angle and the cases in each group examined in detail.

Group A.—Angle of Inclination of the Brim 160°–170°

An inclination of this degree is certainly much higher than the average (135°), and if a variation in the angle of inclination is of obstetric significance, the cases in this group should demonstrate it most clearly. There were eight cases in this group and in every case labour was abnormal.

TABLE IV.

Case No.	Inclination of brim	Sacral angle	True conjugate in.	Weight of baby lb.	Weight of baby oz.	Shape of sacrum	Course of labour
1	165°	71°	4·5	8	7	Convex	Head above brim. Trial labour failed. Cæsarean section
43	165°	68°	4·5	8	10	Convex	Head above brim. Failed forceps. Cæsarean section
49	166°	72°	4·1	7	3	Straight	Head above brim. Trial labour failed. Perforation
55	167°	63°	4·5	8	0	Convex	Head above brim. Strong pains. Normal delivery. Stillbirth. Moulding excessive
70	165°	70°	4·2	7	5	Straight	Head above brim. Prolonged labour. Forceps delivery. Stillbirth.
18	165°	80°	4·0	6	1	Curved	Head above brim. Flexed posture. Outlet forceps
68	163°	85°	4·2	6	1	Straight	Head above brim. Flexed posture. Normal delivery.
72	170°	60°	3·6	7	12	Convex	Head above brim. Cæsarean section

It will be seen that in every case the head was above the brim at the onset of labour, and the first question that must be answered is whether the failure of the head to engage in these cases was due mainly to the high angle of inclination or to some other cause. In one case (72) the pelvis was flat, the true conjugate measuring only 3·6 in. In another case (18), there was a slight flattening of the brim, the true conjugate measuring 4 in. In the remaining six cases the measurements of the brim were quite adequate.

The details of the cases were as follows :—

Case 1.—Primigravida, aged 31.

The external measurements of the pelvis were 9 in., 9¾ in., 7 in., 4¾ in. The true conjugate measured 4·5 in. The brim was circular. The inclination of the brim was 165° and the sacral angle measured 71°, a low value. The sacrum was convex.

The head was high above the brim at the onset of labour and was still high after twenty-eight hours of first stage pains. When the cervix was only three-quarters dilated the flexed position was adopted and the head advanced a little further, but did not come right down into the pelvis. A Cæsarean section was performed and a living child weighing 8 lb. 7 oz. delivered.

The case may be summarized as one in which a long trial labour aided by posture was unsuccessful despite a brim of reasonable dimensions. The causes of the trial labour failing would appear to be the low sacral angle and the convex sacrum ; the initial non-engagement of the head was due to the high inclination of the brim.

Case 43.—*Primigravida, aged* 21.

The external pelvic measurements were normal. X-ray measurement of the true conjugate showed it to be large, 4·5 in. The inclination of the brim was 165°, the sacral angle very low, 68°. There was a convex sacrum. The brim showed slight "beaking" of the fore-pelvis.

She was admitted as a "failed forceps" with a retraction ring. Labour had lasted forty hours. The vertex was still above the brim lying in a transverse position. A Cæsarean section was done, the child weighing 8 lb. 10 oz.

The dystocia was due to the association of a high angle of inclination with a very low sacral angle and a convex sacrum. There was no actual disproportion between the size of the brim and the size of the vertex.

FIG. 1. FIG. 2.

FIG. 1.—Case No. 1. The case illustrates the unfavourable combination of high inclination of the brim, a low sacral angle and a convex sacrum. Angle of inclination 165°, sacral angle 71°. True conjugate 4·5 in.
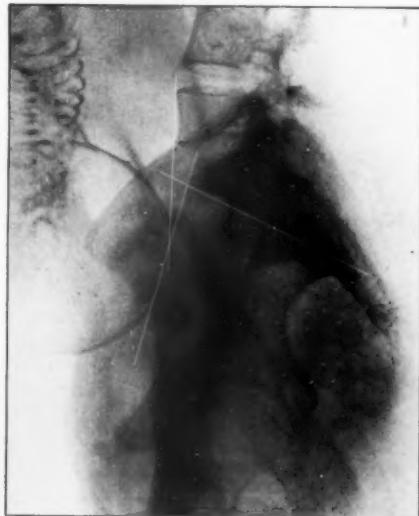Trial labour failed despite posture. Cæsarean section was necessary.

FIG. 2.—Case No. 18. Angle of inclination of the brim 165°, sacral angle 80°, curved upper sacrum, true conjugate 4 in. Postural treatment successful, low forceps delivery.

Case 49.—*Primigravida, aged* 34.

In this case the true conjugate measured 4·1 in. The brim showed slight "beaking" of the anterior segment. The angle of inclination of the brim was 166° and the sacral angle 72°, a low figure. The sacrum was straight.

The head was still high above the brim after 17½ hours of first stage pains, at which time the fœtal heart went off and a perforation was performed, a child weighing 7 lb. 3 oz. being readily extracted later.

The main factor in the dystocia was clearly the conjunction of a high inclination of the brim · with a low sacral angle. Reviewing the case after the event it is clear that a trial of labour should not have been undertaken in view of the low sacral angle.

Case 18.—*Primigravida, aged* 31.

The external pelvic measurements were 10 in., 10¾ in., 7½ in., promontory not reached. The true conjugate measured 4 in. The brim was slightly flattened in shape. The angle of inclination of the brim was 165°, the sacral angle 80°. The sacrum showed a normal curve.

The head was free above the brim at the onset of labour. With the help of the crouching posture the engagement occurred and a low forceps delivery was all the assistance necessary. The first stage of labour lasted 11¼ hours, the second 2¼ hours. The child weighed 6 lb. 1 oz.

The case shows how the flexed posture can successfully counteract an unduly high inclination of the brim in cases in which the sacral angle is high. Despite the high head, a trial labour was the proper procedure in view of the space made available just below the brim by the well-tilted and normally shaped sacrum.

Case 55.—Primigravida, aged 28.

The pelvic measurements were good—9½ in., 11 in., 8¾ in., promontory not reached. X-ray measurements of the brim were not made. The inclination of the brim was 167°, the sacral angle was 63°, one of the lowest figures we noted in the series. The sacrum was almost vertical and the upper sacrum was convex.

The head was high at the onset of labour, but when labour commenced the pains were very violent and the head went into the pelvis quickly. The first stage lasted 10 hours and the second stage 1¾ hours. The child, which weighed 8 lb., was stillborn. Forceps were not necessary. The fœtal head showed marked moulding.

This case is most interesting. It is sometimes claimed as an advantage of trial labour that the uterine contractions will sometimes unexpectedly solve difficulties. In this case they did certainly overcome the mechanical difficulties but at the expense of the baby. In the light of this case one would hesitate to recommend a trial labour when the sacral angle is as low as 63° and the upper sacrum is convex.

Case 68.—Primigravida, aged 21.

The true conjugate measured 4·2 in., the upper sacrum was straight, the angle of inclination of the brim was 163°, the sacral angle was 85°, a high value for this group. The shape of the brim and of the outlet were normal.

The head was high above the brim at the onset of labour but posture was very successful, a normal delivery occurring after a total labour of 12 hours. The baby weighed 6 lb. 1 oz.

The success of trial labour aided by posture in this case of a non-engaged head due to a high inclination of the brim is attributable to the high sacral angle.

Case 70.—Primigravida, aged 29.

The true conjugate measured 4·2 in., the angle of inclination of the brim was 165°, the sacral angle was 70°. The upper sacrum was straight, the brim was circular, the outlet was normal.

The head was above the brim at the onset of labour and dilatation was still incomplete after 71 hours. By this time the head was lying in the transverse diameter of the brim. Kielland's forceps could not be applied, a not uncommon feature in these cases of high inclination associated with deep transverse arrest. A manual rotation was performed and a stillborn child weighing 7 lb. 5 oz. extracted with forceps.

The only abnormal pelvic characteristic was the high angle of inclination. The measurements and shape of the pelvis were normal and the size of the child was normal. The failure of trial labour was due to the conjunction of a high inclination of the brim with a low sacral angle and possibly a straight upper sacrum.

Case 72.—Primigravida, aged 29.

The true conjugate measured 3·6 in. The angle of inclination of the brim was 170°, the sacral angle measured 60°. The pelvic brim showed flattening and a shallow posterior segment, the transverse diameter of the brim being 5·2 in. The sacrum was convex and six sacral segments were present.

The head was free above the brim and over-riding at term, and an elective Cæsarean section was performed. The child weighed 7 lb. 12 oz.

The case illustrates how a high inclination of the brim may be associated with flattening, a point first noted by Mackenzie in 1923.

It will be seen that in all but one of the eight cases the pelvic measurements were adequate and the only feature they had in common was a high inclination of the brim. The non-engagement of the head at term can only have been due to the abnormal inclination.

The histories of the labours show that the size of the sacral angle, or in other words the tilt of the sacrum, was the main factor determining whether the mechanical difficulties caused by the high inclination could be overcome. Cases of this type, i.e. patients in whom the head is high despite normal measurements, are usually selected for trial labour, and an examination of the factors responsible for the success or failure of the trial labours in the series is important.

Briefly, it would appear that with a high inclination of the brim trial labour is not to be recommended when the sacral angle is low and the sacrum is convex. An elective Cæsarean section is safer practice in such a case.

Group B.—Angle of Inclination of the Brim 150°–159°

An angle of inclination of the brim of 150° to 159° is significantly higher than the average (135°) and in accordance with this a high incidence of dystocia was again noted in this group, though not so high as in the 160° to 170° group. In the 13 cases in this group dystocia occurred eight times, in two cases the head did engage with the help of posture, and in the remaining three cases labour was normal.

TABLE V.

Case No.	Inclination of brim	Sacral angle	True conjugate in.	Weight of baby lb. oz.	Shape of sacrum	Course of labour
37	153°	66°	3·7	5 12	Convex	Head above brim. Small baby. Normal delivery.
47	150°	103°	3·6	9 4	Convex	Head above brim. Elective Cæsarean section.
65	150°	90°	3·7	7 14	Convex	Head above brim. Elective Cæsarean section
4	155°	83°	4·0	7 9	Convex	Head above brim. Flexed posture. Normal delivery.
56	150°	99°	4·0	7 8	Straight	Head down. Normal delivery.
64	155°	85°	4·0	6 12	Convex	Head down. Normal delivery.
66	150°	85°	4·0	6 0	Convex	Head above brim. Posterior position. Forceps delivery. Stillbirth.
33	155°	73°	4·2	5 0	Convex	Head above brim. Normal delivery. Small baby.
71	150°	78°	4·2	7 14	Convex	Head above brim. 1st forceps. 2nd prolapsed cord.
6	151°	89°	4·5	6 10	Straight	Head above brim. Flexed posture. Normal delivery.
10	150°	85°	4·5	8 0	Straight	Head half in. Posterior position. Forceps delivery.
13	155°	75°	4·5	8 9	Straight	Head above brim. Trial labour failed. Cæsarean section.
16	156°	85°	4·5	9 13	Straight	Head above brim. Posterior position. Forceps delivery.

The table shows that in three of the cases, 37, 47, and 65, the pelvis was flat, and the failure of the head to engage at term was due to this cause. In the remaining ten cases there was no pelvic contraction present. In seven of these ten cases the head was either above the brim at term or dystocia occurred. The details of three of these cases may be considered.

Case 13.—Primigravida, aged 24 (Chinese).

The true conjugate measured 4·5 in., the angle of inclination of the brim was 155° and the sacral angle 75°. The brim was anthropoid in type. The upper sacrum was straight. The head was still above the brim 12½ hours after the onset of labour and a Cæsarean section was performed, the child weighing 8 lb. 9 oz.

The sacral angle was low in this case, only 75°, and this may have been a secondary factor in the dystocia, the initial non-engagement of the head being due to the high inclination of the brim.

Case 16.—*Primigravida, aged* 30.

The brim was roomy, the true conjugate measuring 4·5 in. The angle of inclination of the brim was 156°, the sacral angle was 85°. The brim was circular.

The head was above the brim at term. The first stage of labour lasted 18½ hours and the second stage 3 hours. A forceps rotation and extraction was necessary, the child weighing 9 lb. 13 oz. Here again Kielland's forceps were difficult to apply.

The high inclination of the brim was responsible for the non-engagement of the head at term, but the high sacral angle compensated for this, so that engagement did ultimately occur and vaginal delivery was possible. The arrest of the head took place in the mid-pelvis and was not due to the high inclination of the brim, but to a combination of a posterior position and a large baby.

Case 71.—1–*Para, aged* 28.

The true conjugate measured 4·2 in. The angle of inclination of the brim was 150° and the sacral angle 78°. The upper sacrum was convex. The brim showed a shallow posterior segment. There was some outlet contraction, the subpubic angle being 75°. The sacro-sciatic notch was narrow.

Her first labour ended in a difficult Kielland's forceps extraction of a posterior position. After it she had a peroneal palsy. In her second labour, the cord prolapsed while the head was still high and a stillborn child weighing 7 lb. 14 oz. was extracted by the breech.

While the male characters of the cavity of the pelvis were responsible for some of the dystocia the course of the second labour made it clear that the main arrest took place at the brim and was due to a combination of a high inclination of the brim, a convex sacrum, a diminished sacral angle and a flattening of the posterior segment.

In two of the cases in which the head was above the brim at term postural treatment was deliberately adopted. The details of one of these cases are as follows :—

Case 4.—*Primigravida, aged* 27.

The true conjugate measured 4 in. The angle of inclination of the brim was 155° and the sacral angle was high, 83°. The upper sacrum was slightly convex. The brim was circular.

The head was above the brim at term. The crouching position was adopted at the onset of labour and engagement readily occurred, a child weighing 7 lb. 9 oz. being born naturally after a total labour of 11 hours.

These two cases support the view that a trial labour may be undertaken with confidence when a high inclination of the brim is counterbalanced by a high sacral angle.

Of special interest are the three cases in this group in which, despite the high angle of inclination, there was no delay in the engagement of the head.

In the first case (33) the head was engaged at term and delivery was normal despite a low sacral angle and a convex sacrum. Fortunately for our thesis the weight of the child was only 5 lb.

In the second case (56) a 7½ lb. child was delivered naturally on the district, despite an angle of inclination of the brim of 150° and a true conjugate of 4 in., but on the other hand the sacral angle had the relatively high value of 99° and the sacrum was straight and not convex. The favourable issue of the labour was due to the high sacral angle.

The remaining case (64), in which a 6 lb. 12 oz. baby was born normally on the district, again may be taken to illustrate the favourable effect of a high sacral angle, 85°. The upper sacrum was convex in this case, bearing out a general impression that the upper sacral shape, while it certainly has some significance, is less important than the sacral angle in determining the passage of the head through the upper pelvis.

Group C.—Angle of Inclination of the Brim 140°–149°

There were 30 cases in this group.

An angle of inclination of the brim of 140°–149° is not very much higher than the normal and, if our general argument is sound, we should expect to find fewer cases of non-engagement and slow engagement of the head in this group, excluding cases in which some definite cause such as pelvic flattening is present.

In the group of 30 cases there was definite pelvic contraction in eight cases, the true conjugate measuring less than 4 in. Five of these needed Cæsarean section, a sixth had a stillborn breech delivery, in the remaining two cases (28 and 32), delivery was normal.

In Case 28 the head was engaged at the onset of labour. In Case 32 the head was above the brim at term but was helped to engage by the use of posture. The details of this case are as follows :—

The angle of inclination of the brim was on the high side, 148°, the sacral angle was 100°, the true conjugate 3·9 in. The sacrum was straight.

At the onset of labour the head was above the brim, lying in asynclitism but with the aid of posture engagement readily took place and a 6 lb. 15 oz. child was born naturally after a total labour of 19 hours.

The late engagement of the head was due to relative disproportion and a fairly high inclination of the brim. The case well illustrated the favourable effect of a high sacral angle in compensating for a relatively small conjugate.

There remain therefore 22 cases in this group in which the measurements of the brim were normal. The head was above the brim at term in only eight of these 22 cases.

The details of four of these eight cases are as follows :—

Case 14.—*Primigravida, aged* 22.
The angle of inclination of the brim was 142°, the sacral angle was low, 72°. The upper sacrum was convex. The true conjugate was 4·3 in. The brim showed a slightly shallow posterior segment but the anterior segment was normal and the sacro-sciatic notch was feminine in type.

The head was above the brim at term but readily engaged at the onset of labour and the first stage lasted only 15 hours. Deep transverse arrest occurred and a difficult forceps extraction of a 6 lb. 5 oz. baby was necessary after a long second stage.

It seems reasonable to relate the transverse arrest to the convexity of the sacrum and the low sacral angle.

Case 51.
This patient had a true conjugate of 4 in. The angle of inclination of the brim was 147° and the sacral angle 69°, a low value ; the sacrum was convex. The brim was slightly flat. The head remained above the brim and an elective Cæsarean section was performed. The child weighed 9 lb. 13 oz.

It is clear that the cause of non-engagement of the head was relative disproportion between the head and the brim, aggravated by a relatively high angle of inclination of the brim. In view of the low sacral angle and the convex sacrum, it is well a trial of labour was not undertaken.

Case 72.—*Primigravida, aged* 24.
The angle of inclination of the brim was on the high side, 148°. The sacral angle was 82°. The true conjugate measured 4 in. The upper sacrum was slightly convex. The brim was gynecoid.

This patient was admitted as an emergency with the head above the brim. She had been in labour over three days before admission and it was the recognition of the relatively high sacral angle that emboldened us to continue with expectant treatment and posture. The baby weighed 7 lb. 14 oz. A low forceps delivery was all that was ultimately necessary. Delivery was complete seven hours after the adoption of postural treatment, which was instituted soon after she was admitted to hospital.

Case 2.—*Primigravida, aged* 24.
The true conjugate measured 4·3 in. The angle of inclination of the brim was 143°, the sacral angle high, 102°, the sacrum convex. The fore-pelvis was " beaked ". The sacral notch was wide.

At term the head was high but engagement readily took place and normal delivery occurred after a total labour of 27 hours. The child weighed 6 lb. 14 oz.

While the head was high at term there was no real delay in its engaging when the pains began. The case illustrates the favourable import of a high sacral angle and a normal sacral shape.

To recapitulate, there were 22 cases in this group in which the measurements of the brim were adequate and in eight of these the head was above the brim at term. This is a lower proportion than was noted in the former groups. With the possible exception of Cases 53 and 51, in no instance was there any marked delay in the engagement of the head. The only Cæsarean sections needed in the group were elective.

A general review of the group shows that the cases in which cavity dystocia, as distinct from non-engagement of the head, occurred were those in which the sacral angles were low. Of the four cases in which the angle was below 80° cavity dystocia occurred in the three in which the sacrum was convex, normal delivery in the one in which the sacrum was straight. In the remaining 18 cases in which the brim measurements were normal and the sacral angle was over 82° cavity arrest only occurred twice.

This is shown in the following table :—

TABLE VI.—TYPE OF LABOUR IN RELATION TO SACRAL ANGLE AND SHAPE IN 140°–149° GROUP.

Case No.	Sacral angle	Sacral shape	Type of brim	True conjugate in.	Labour
5	93°	Straight	Flat	3·5	Cæsarean section
9	93°	Convex	Flat	3·5	Cæsarean section
15	97°	Normal	Flat	3·6	Cæsarean section
54	85°	Convex	Flat	3·6	Breech Stillborn
63	85°	Curved	Flat	3·8	Cæsarean section
28	86°	Curved	Flat	3·9	Normal delivery
11	97°	Normal	Flat	3·9	Cæsarean section
32	100°	Straight	Normal	3·9	Normal delivery
51	69°	Convex	Flat	4·0	Cæsarean section
14	72°	Convex	Android	4·3	Deep transverse arrest
48	73°	Convex	Normal	4·0	Persistent occipito-posterior
3	80°	Straight	Normal	4·2	Normal delivery
40	82°	Straight	Anthropoid	4·7	Low forceps
72	82°	Convex	Normal	4·0	Low forceps
27	84°	Convex	Normal	4·6	Normal delivery
69	85°	Straight	Normal	4·2	Normal delivery
53	88°	Straight		4·5	Cæsarean section (elective)
12	90°	Curved	Normal	4·3	Normal delivery
38	90°	Straight	Normal	4·2	Low forceps
22	85°	Curved	Normal	4·0	Mid. forceps
17	85°	Straight	Android	4·4	Normal delivery
19	85°	Curved	Anthropoid	4·6	Normal delivery
23	87°	Curved	Normal	4·5	Low forceps
26	90°	Curved	Anthropoid	4·6	Normal delivery
20	90°	Straight	Normal	4·5	Normal delivery
31	90°	Straight	Doubtful	4·0	Normal delivery
8	90°	Convex	Doubtful	4·1	Normal delivery
24	93°	Straight	Android	4·0	Deep transverse arrest
25	97°	Straight	Normal	4·0	Normal delivery
2	102°	Curved	Android	4·3	Normal delivery

Group D.—Angle of Inclination of the Brim 130°–139°

There were 10 cases in the series with angles of inclination of the brim between 130°–139°. An angle of this degree may be considered approximately normal and these cases form a good control group.

In only two cases was the head high above the brim at the onset of labour. In the remaining eight cases it was in the pelvis when labour started. It seems advisable to give details of the two cases in which the head was above the brim. Both these patients were overdue by dates.

In the first case (42) the patient was a primigravida, aged 32, and postmature by dates. The angle of inclination of the brim was 138°, the sacral angle was 100°. The true conjugate measured 4·3 in. The upper sacrum was convex.

The head was above the brim at term, but labour lasted only 21 hours and delivery was normal. The child weighed 7 lb. 15 oz.

In the second case (45) the patient was a primigravida aged 20. The angle of inclination of the brim was 132° and the sacral angle was 105°. The pelvis was roomy (promontory not reached). The sacrum was fully curved. The first stage of labour lasted 46 hours, the second stage 3¼ hours. A low forceps delivery was necessary. The baby weighed 7 lb. 13 oz. She was two weeks overdue.

With the data available, the non-engagement of the head at term cannot be accounted for. On the other hand, trial of labour was successful as would be expected from the high sacral angle and the curved sacrum. Postmaturity may have been the cause of the late engagement of the head.

Study of the group as a whole shows that, given a normal inclination of the brim and a high sacral angle, little difficulty need be anticipated with engagement of the head and its passage through the upper pelvis except in cases of gross contraction.

Group E.—Angle of Inclination of the Brim 120°–129°

There were eight cases in this group. An angle of inclination of the brim below 130° should not, if our contention is correct, be associated with a high head except in the presence of some definite cause such as contracted pelvis. Indeed a low angle might be expected on *a priori* grounds to compensate for some degree of pelvic contraction.

Of the eight cases the head was above the brim at term in three instances. The late engagement of the head in one case was due to relative disproportion due to a large child, which weighed 9 lb. 10 oz.

In the second case (57) the head was above the brim in a posterior position at the onset of labour but readily engaged. The true conjugate was 4 in., the child weighed 6 lb. 14 oz. The fore-pelvis was android. There was an excess of liquor amnii and engagement occurred immediately the membranes were ruptured.

In the third case (61), the head was freely movable above the brim at the onset of labour. The true conjugate measured 4·1 in., the child weighed 7 lb. 7 oz. The sacral angle was high, 108°, the upper sacrum was straight and the brim was slightly flattened.

Despite the high head labour was normal, engagement readily occurring early in labour.

In one case (58), a low inclination of the brim did compensate for small measurements. Although the true conjugate measured 3·8 in., and the child weighed 7 lb. 12 oz., the head was in the pelvis at the start of labour and delivery was normal. This favourable issue was due to the combination of a low angle of inclination of the brim, 120°, a normal sacrum and a very high sacral angle of 117°.

General Discussion

A consideration of the clinical histories of these 69 cases shows that, given normal measurements of the brim, the commonest cause of non-engagement of the head at term is an abnormally high inclination of the brim, although other factors such as postmaturity or a large child lying in a posterior position may sometimes be to blame. In one case certainly, possibly in another, an android shape of the brim was the cause.

In the group of cases in which the inclination of the brim was over 160° non-engagement of the head was the rule even when the brim was roomy. On the other hand, in the group in which the inclination was below 130° engagement of the head was the rule, and the low inclination seemed to compensate in one case at all events for a contraction of the brim.

The point may be raised whether some other pelvic characteristic, such as an android brim, was responsible for the difficulties which we have attributed to a high

inclination. All the cases were considered from this standpoint, but no correlation could be established between the type of the brim and non-engagement of the head. In this regard it is most important to remember that we have only been concerned with the passage of the head into and through the upper pelvis. Certainly, arrest taking place in the pelvic cavity could in a few instances be ascribed to android characters, but on the other hand many of the cavity arrests occurred in typically gynecoid pelves.

The clinical importance of an abnormal inclination of the brim depends largely on the general inclination and to a lesser degree on the sacral shape. It would appear that the success or failure of the uterine contractions in overcoming the mechanical difficulty imposed by a high inclination depends on these two factors. Reference to Table II shows that the average sacral angle was 71° in the 160°–169° group. In the two cases in this group in which normal delivery ultimately occurred the sacral angle was significantly higher than the average, 80° and 85° respectively.

As regards the influence of the sacral shape, here again the cases show that there is a greater incidence of convex sacra in the higher groups and in those cases in which upper pelvic delay took place.

As in the case of high inclination we could not establish any correlation between abnormal sacral inclination and abnormal sacral shape on the one hand and any standard classification such as that of Caldwell and Moloy (1933).

A pelvis in which the angle of inclination is high, the sacral angle is low and the upper sacrum convex does not fall into any accepted classification, but seems to be of such obstetrical importance that it might merit being considered a special type.

The obstetrical importance of sacral shape and constitution has long been a matter of debate and it is quite definite that the older views of the importance of the high and low assimilation pelvis have not stood the test of radiological pelvimetry. In clinical practice it would appear that the actual morphology of the sacrum is not of much importance. What is important is the curve of the lumbosacral junction. Essentially the characters we have been investigating, viz. the inclination of the brim, the inclination of the upper sacrum and the shape of the upper sacrum are methods for measuring this curve. Although for comparative purposes such as measuring angles it is necessary to regard the inlet as a plane, in practical obstetrics the inlet must be regarded as having depth and it is in this way that the three factors which we are considering are related.

At the start of the inquiry it seemed likely that asynclitism would be found to be of importance. It proved, however, impossible to get reliable data on this point either by pelvimetry or even at Cæsarean section, and we were obliged to leave the question undecided.

Garret and Jacob's (1936) observation that posterior asynclitism is a favourable attitude could not be confirmed.

DIAGNOSIS

A high inclination of the brim is to be suspected when the head is high at term and the pelvic measurements seem normal. A pendulous abdomen may also be a guide. The head feels unduly prominent and when attempts are made to push it down into the pelvis it becomes more so. If the patient is propped up the head feels less prominent and more fixed.

Inclinometer readings are unreliable and the final exact diagnosis is radiological, although in emergencies the empirical test of posture is worth a trial.

TREATMENT

Trial labour.—It is in the cases of high inclination of the brim with normal measurements that a trial of labour as a formal procedure finds one of its most important applications. A study of our cases shows that "trial labour" often failed,

and it might even be said that the value of X-ray pelvimetry will ultimately stand or fall by its value in eliminating this uncertainty. Each case must be judged individually but it does appear that successful issue to a trial labour is only likely when the sacral angle is high and the sacrum shows no gross convexity. On the other hand, discovery of a low angle of inclination of the brim and a good sacral angle may justify a trial labour even in a case where there is some pelvic contraction.

Postural treatment finds one of its main applications in cases of high inclination of the brim. The use of posture in the practice of obstetrics has been rather neglected, possibly because of early disappointment at its effect upon the actual size of the various pelvic diameters. In 1766 Smellie wrote of its value : " Should the labour prove tedious the Parisian method seems most eligible ; because when the patient half sits, half lies, the brim of the pelvis is horizontal. In this position the weight of the waters and the child's head will gravitate downwards and assist in opening

FIG. 3.　　　　　　　　　　　　　　　FIG. 4.

FIGS. 3 and 4.—Case No. 26. The films show the effect of the flexed posture. The angle of inclination of the brim is reduced from 148° to 129°. The sacral angle is reduced from 90° to 85°.
Posture aided engagement of the head, delivery was normal. Note in this regard the normal upper sacrum and the adequate sacral angle.

the parts, while the contracting force of the abdominal muscles is more free, strong and equal in this than in any other attitude."

The adoption of a flexed posture has two effects upon the entry of the head into the pelvis. It reduces the angle of inclination of the brim (figs. 3 and 4) and at the same time permits the uterus to come forward and align itself with the axis of the inlet, an axis which is more horizontal than normal when the brim is unduly inclined.

Postural treatment proved very successful in some of our cases. The patient may be made to sit crouching forward with the legs flexed, or told to stand and lean forward on a low chair or bed throughout each pain.

When the advisability of postural treatment is being considered it is nevertheless important to bear in mind all the effects of flexion of the trunk and legs. In the introduction the effect of flexion in diminishing the sacral angle, i.e. making the sacrum

more vertical, was shown, and for this reason the flexed posture loses much of its value as soon as the head is half through the brim. Moreover it is likely to be of little value in a case where the sacral angle is already low, the type of case in which a trial labour should not be undertaken.

SUMMARY

(1) The inclination of the pelvic brim is best measured by the angle formed between the plane of the brim and the front of the body of the 5th lumbar vertebra. The average angle is 135° but the angle varies considerably in different patients, the range of variation being 120°–170°.

(2) The angle of inclination can be lowered by the adoption of a flexed posture, the range of variation being 3°–20°.

(3) A high angle of inclination of the brim is a cause of non-engagement of the head in women with normal pelvic measurements.

(4) The sacral inclination, measured by the sacral angle, and the sacral shape are accessory factors controlling the full engagement of the head.

(5) High inclination of the brim commonly occurs in association with a low sacral angle and a convex sacrum.

(6) A pelvis with these characteristics is difficult to classify, but is of considerable obstetric importance.

(7) The success or failure of trial labour in a case of high inclination of the brim does not depend only on the relative sizes of the brim and the fœtal head, but on the sacral inclination and shape, and it should not be undertaken when these are unfavourable.

(8) Postural treatment is a valuable adjunct to trial labour in cases of high inclination of the brim, but it is subject to some limitations, mainly those imposed by sacral angle and shape.

We are very much indebted to Dr. R. E. Roberts, whose radiological methods of pelvimetry we have used, for much help and advice, and also to Dr. P. H. Whitaker and Dr. E. L. Rubin, under whose careful supervision the radiological work was done.

REFERENCES

CALDWELL, W. R., MOLOY, H. C. (1933), *Am. J. Obst. & Gynec.*, **26**, 479.
GARRET, W. Y. P., JACOB, J. B. (1936), *ibid.*, **31**, 389.
JACOB, J. B. (1934), *ibid.*, **28**, 227.
MALPAS, P. (1936), *Tr. North of England Obst. & Gynec. Soc.*, 49–51.
MACKENZIE, W. R. (1923), *J. Obst. & Gynæc. Brit. Emp.*, **30**, 556.
MEYER, R., " Statik u. Mechanik des Menschlichen Knochengerüstes ". Leipzig, 1873.
NEUMANN, and EHRENFEST, H. (1900), *Monatschr. f. Geburtsh. u. Gynäk.*, **11**, 253.
REED, C. B., SERBIN, W. B., " Obstetrics and Gynæcology ". Curtis, Philadelphia, 1934.
SCHEYER (1932), *Zentralbl. f. Gynäk.*, **26**, 1585.
THEOBALD (1936), *Proc. Roy. Soc. Med.*, **22**, 1488 (Obstet. & Gynæc., 54).
THOMS, H. (1935), *Surg., Gynec., & Obst.*, **60**, 680.
WILLIAMS, WHITRIDGE, " Obstetrics ". New York, 1924.

Section of Ophthalmology

President—Malcolm Hepburn, F.R.C.S.

[*March* 10, 1939]

Clinical Meeting at the Bristol Eye Hospital

Four cases shown by A. E. Iles, F.R.C.S.

Hyaline Bodies at Optic Disc R. and L. Pigmentary Degeneration of Retinæ, Glaucoma R. and L.

W. I., male, aged 36.

This case was reported by Mr. Walker in 1915, *vide Tr. of Ophth. Soc. U.K.*, Vol. **34**.

R.V. : No P.L. L.V. : Hand movements.

I show this patient because I saw him first when he was aged 6. He had then well-marked hyaline bodies and not much pigmentary degeneration. The degeneration began subsequent to that, and finally he had glaucoma in each eye, for which he was operated upon. He has hand movements in left eye and is quite blind in the right. I thought it would be interesting to show this case because the hyaline bodies are not so marked as when I saw him first, being flatter and less distinct.

Discussion.—The President said that hyaline bodies and pigmentary degeneration were not very uncommon.

Mr. Maurice Whiting asked if it was possibly a specific case; also whether there were inflammatory changes at the time the operation was done.

Mr. Iles replied that the Wassermann was negative. He himself did not perform the operations for glaucoma.

Unilateral Proptosis R. Krönlein Operation.

G. S., female, aged 31.

Hæmangioma removed from orbit—adherent to optic nerve. Diplopia after operation, and permanently dilated pupil which reacts to pilocarpine.

$$\text{R.V.} \quad \frac{+\ 2.25 \text{ D. sph.}}{+\ 0.5 \text{ D. cyl.}\ \searle} = \frac{6}{9}. \qquad \text{L.V.} \quad \frac{+\ 0.25 \text{ D. sph.}}{+\ 0.5\ \searle} = \frac{6}{6}.$$

The hæmangioma was partly wrapped round the optic nerve, and some difficulty was experienced in taking it out. It was necessary to divide the external rectus. The woman made an uninterrupted recovery. This case is of interest in that a permanently dilated pupil has remained since operation.

Mr. LINDSAY REA said he thought this was about the finest result he had ever seen following a Krönlein operation. In connexion with the immobility of the pupil he narrated a case of his own where the optic nerve involved in a tumour was removed by Mr. Cairns and the eyeball left in situ. To the ordinary ophthalmoscopic light the pupil was inactive. However, in order to photograph the appearance of the abbreviated optic nerve a Nordensen arc light was used. To the astonishment of one and all the pupil contracted down and remained so for about half an hour. This case has been mentioned in " Neuro-Ophthalmology ", London, **1938**.

Recessive Sex-linked Blindness.

K., male, aged 8.

R.E. : Clear cornea ; iris tremulous ; lens light yellow and dislocated down and out. Fringes of iris pigment adherent to lens.

L.E. : Corneal opacities. New formed vessels seen running from iris down over lens capsule. A.C. rather shallow. Lens greyish and soft in appearance.

This is a very interesting family from Yorkshire. I came across members of it at the Stoke Park Colony when I was consultant there. The family has been traced back for two hundred years, and apparently there is now only one female to carry it on, so that it is practically extinct. All these children are born blind. All have apparently inflamed eyes, though the mothers are most emphatic that the eyes have always been white and never shown any inflammation at all. No two eyes are alike. This boy has a white lens in one eye and a yellow lens in the other. The brother of this boy who was similarly afflicted died, and I sent his eye for section. There was a new bone formation in the region of the choroid, with small round-celled infiltration. This is one of the few families definitely associated with mental deficiency. There is one family in Leeds where the eldest boy is a Braille expert and very bright, the second boy is an imbecile and the third an idiot. The family was reported upon by Ash in 1912, but he did not realize the association with mental deficiency, and by Fraser Roberts in 1938 who observed the mental deficiency factor.

Discussion.—Mr. W. J. B. RIDDELL said that it might be a matter of some interest to test the colour vision of the affected brothers and cousins. There might, for example, be colour blindness in the cousins and not in the brothers. He understood that there were unaffected brothers and cousins in Yorkshire.

Mr. ILES said that the family was in Yorkshire, and several days had been spent in searching out the family history.

Congenital Retinal Bands.

B. S., aged 9.

Nystagmus, floating web well forward in vitreous L.

R.V. $\bar{c}$ $-$ 1 D. sph. $= \frac{6}{36}$ partly.   L.V. $\dfrac{-\ 1 \cdot 5 \text{ D. sph.}}{-\ 1 \text{ D. cyl.} \rightarrow} = \frac{6}{36}$.

This boy first came up with nystagmus. It is very difficult to see, but in the right eye there is a very fine membrane running upwards and outwards from the disc. I took it to be a persistent retinal band of very small degree, not at all like the one I showed to the Section in London two years ago.

Miss IDA MANN said that this also was an interesting case. It was not absolutely typical of the complete case of congenital retinal fold, because, for one thing, the fold did not come out far enough, and, again, the persistent hyaloid was not adherent to the edge of the fold as it was in all her own cases. Thus this was the least possible degree of retinal fold. She did not think it possible to tell which was the primary abnormality in the left eye, but taking the two eyes together it was, she thought, the persistent hyaloid.

Pathological Specimen—Spontaneous Rupture of Globe.—A. E. ILES, F.R.C.S.

Secondary glaucoma following thrombosis of the central vein.

This pathological specimen is from a patient, a woman, whom I saw in July 1937, with a thrombosis in the central vein. Her tension was then somewhat raised. I gave her pilocarpine and told her to come back if there was pain. I saw her again in November of that year when spontaneous rupture of the globe had taken place. Her husband said that his wife had suffered severe pain during the days preceding the rupture. I have looked up the literature of the subject, but cannot find any case of a similar kind.

Discussion.—Mr. ILES said that the tension was raised when he saw her in July. As subacute glaucoma might arise she was told to come back at once to him if she had pain. She stated that she had terrific pain for at least a week before the catastrophe, and had been unable to sleep. She said, " You cannot imagine the pain I have suffered ". The case had a five months' history, from June to November, when the rupture took place. The rupture was in the ciliary region. He had traced 14 reported cases of spontaneous rupture, but in none of them was the cause secondary to venous thrombosis.

Mr. COLLEY said that four years ago he had seen a woman aged 77 who had thrombosis of the central retinal vein. Two years later the tension of the eye became raised and he advised excision, but this was refused. Drops of pilocarpine were ordered and the pain was to a large extent relieved.

Eighteen months later the pain increased, and a spontaneous rupture of the cornea occurred —a large clot of blood extruding through the opening. No history of trauma was obtained.

Mr. MAURICE WHITING said that it seemed difficult to imagine how a spontaneous rupture could occur. How could tension in the eye be so considerable that it could burst a relatively normal cornea ? On the other hand, it seemed very likely that a person suffering a great deal of pain might give the eye a hard rub or apply pressure, almost unconsciously.

Mr. ILES said that one case which he found in literature was reported by a surgeon in Montreal who performed needling for congenital cataract on a small boy and sent him home to his general practitioner fifty miles away, telling him to let him come back to hospital if there was pain. Six weeks later a rupture occurred due to glaucoma secondary to swelling of the lens.

Dermoid of Right Limbus.—A. E. ILES, F.R.C.S.

S. A., female, aged 3 months. Congenital abnormalities.

R. E. dermoid of limbus. L.E. normal.

Left ear: many accessory auricles. Accessory tubercle in cleft between upper and lower R. facial processes.

Left thumb shows accessory terminal phalanx.

This is an infant with a dermoid of the right limbus, also tubercle in the right facial cleft, accessory auricles and two distal phalanges of L. thumb. I have never seen so many congenital abnormalities in one child. The father and mother are not related.

Streaks in Retina—Congenital Bands.—B. GLUCK, F.R.C.S.Ed.

Q. E., aged 18. This patient came up to see whether anything could be done to improve the vision. Dark bands were found lying in the posterior layers of the retina, and associated with this condition was a certain amount of disturbance of the disc. At the periphery of the visual area can be seen grey or whitish areas extending from the end of the dark streaks. The question is whether it is a

congenital condition or the result of an accident. The patient gives a history of accident due to the pecking of his brow by a cockerel when he was about 6 years old, but he cannot recollect whether the eye was injured or not.

Mr. R. A. GREEVES said that he thought this was probably a traumatic condition; a detachment of the retina was present in the lower periphery, and an oral tear could be seen in the detached part.

He thought it not unusual for bands of white tissue to develop between the retina and choroid at the edge of a detachment, and in cases in which a detachment had receded a succession of such bands could sometimes be seen. With regard to the nature of the tissue forming the bands, he thought it was a product of the pigment epithelium, resembling the material of which colloid bodies were made. This view was based on his experience of microscopical sections.

Vascular Anomaly of Left Retina.—RAMSAY GARDEN, M.B., D.O.M.S.

M. P., female, aged 32.

The left fundus shows near the outer side of the disc a dilated vein of irregular calibre in association with a rounded area of distended capillaries. ? congenital anomaly. Vision $\frac{6}{6}$. This patient came to hospital in January this year complaining of headaches and pain behind both eyes. In the course of examining the fundi, I discovered this varicose condition and regarded it as a congenital abnormality. A skiagram of the skull was taken, and a star-shaped shadow was seen on the left parietal region, which the senior radiologist, Dr. Bergin, agreed might be an angiomatous lesion on or near the inner surface of the bone.

There is a history of this patient having had a period of unconsciousness about two months ago. This lasted about two days, and Dr. Price, who was the physician called in to see her at the time, will be able to tell us about her condition then.

Soon after I saw her first, she developed a partial and intermittent right ptosis. The right eye can be opened easily, however, if the other is covered. This symptom is now less troublesome, but she still gets headaches.

Discussion.—Dr. HARRISON BUTLER said that recently he had seen a case in which the appearance was almost exactly the same as in the one shown. This was in a boy of 12 or 13 who attended the Coventry School Clinic. They could not get his vision above $\frac{6}{24}$, and he discovered this little area of dilated capillaries just below or above the macula. The mother was much distressed and wanted him to say what the future prospects would be. He expressed the view that it was a congenital abnormality, and that nothing would happen to it. But he had never seen anything quite like it before until he saw Dr. Garden's case that day, and now that he had seen it he felt that he could go back and say that he had seen a woman of 32 whose vision and condition were absolutely the same as that of this youth, and that nothing had happened.

Dr. N. L. PRICE said that he was called in to see Mr. Ramsay Garden's case about three or four months ago. She was then in a semi-comatose condition in which she had been for two days, and she remained in it altogether for a period just under three days. She was rousable and restless, and there was complete absence of any focal signs indicating lesion of the brain, indeed, a complete absence of anything which could account for the state of coma. He examined the discs but he did not see the vascular anomaly of the left retina, and would be interested to know whether there was any relation between this angiomatous condition and the stupor from which she had suffered. He could not quite fit it in.

Five cases shown by ANTHONY PALIN, F.R.C.S.Ed.

Displacement of Globe by Air-Sinus Osteoma.

C. R., male, aged 27.

Has noticed swelling and slight redness of his eyelids for six months, with some mistiness of vision. R.V. $\frac{6}{9}$; L.V. $\frac{6}{5}$; roughly emmetropic.

Skiagrams showed a huge ivory-type osteoma of frontal and ethmoid sinuses, invading right orbit.

The osteoma (*see* specimen) has been removed a fortnight before this meeting.

Mr. Palin said that, for the six months before he had seen this patient, there had been practically no other symptoms than those of very mild conjunctivitis.

Mr. J. Angell James, in the Nose and Throat Department at the Bristol Royal Infirmary, removed the osteoma which was one of the biggest he had ever seen. He showed skiagrams which revealed that the osteoma had not only invaded the orbit but also had practically eroded into the anterior fossa of the skull, and also projected well down into the nose. Photographs showed the patient before and after the operation which had left no disfigurement at all other than the scar, although a considerable amount of bone had been removed. There was very slight diplopia on looking up and to the left. The Hess screen showed the muscle imbalance to be almost negligible and indicated that it would clear up entirely.

Gross Chronic Swelling of Lids and Face : ? Diagnosis.

L. B., female, aged 54.

Has suffered for six years from massive œdema of the right side of her face and nose. The condition has been variously diagnosed and treated, without any improvement. The most popular diagnosis has been angioneurotic œdema, although the appropriate treatment has produced no benefit.

On the strength of obtaining a persistent *Staphylococcus aureus* culture from the conjunctival sac on that side I have had an autogenous vaccine made, and intend to try that. It seems possible that the condition may be a chronic subdermal infection. Dr. Cass has told me to-day that she has seen similar cases of chronic localized œdema due to inflammatory obstruction of the deep lymphatics in the periosteal layer.

Complete Transverse Rupture of Cornea and Part of Sclera ; Retention of Eye.

M. S., female, aged 27.

R. eye injured one year ago by the explosion of a bottle. Cut or rupture of cornea extended right across it and well on to the sclera on each side. An almost hopeless repair was made with a large conjunctival flap. Eye ultimately recovered and settled down, without K.P. formation.

Now R.V. with $+ 13 \cdot 00$ D. cyl. $= \frac{6}{12}$ partly. L. eye is normal.

This case is remarkable in the fact that the patient has retained the eye. Most surgeons said at the time that it should be removed, but she now has a potentially good eye as a reserve if the other should ever be lost. She had a long convalescence and a red irritable eye for ten weeks which naturally gave rise to some anxiety.

Frequent differential white counts of the blood were made and the eosinophils went up to 7% and the large hyalines to about 14%. After three months the count had entirely returned to normal. The opinion of members is sought as to how far the blood picture should be taken as a guide in deciding on the probability of sympathetic ophthalmia and the desirability of excision.

Foreign Body Removed by Posterior Route ; Good Visual Result.

A. S., male, aged 30.

Six months ago a steel foreign body lodged in the vitreous. After careful localization endothermic cauterization was performed on the area of the sclera overlying the foreign body, which was then easily removed by the hand magnet through a keratome incision, which was afterwards closed with mattress sutures.

Now R.V. $= \frac{6}{5}$ partly. No detachment or vitreous opacities are present, and field is full. The fundus shows no abnormality except the small area of diathermy scarring.

This case is brought forward as a plea for more frequent use of the posterior route for removal of foreign bodies when they cannot be removed by the anterior route or can only be removed by inflicting severe damage to the lens and iris and other structures.

Discussion.—Mr. LINDSAY REA asked how the position was determined for accurate incision. Had katholysis bubbles been used to determine the position of the foreign body.

Mr. PALIN replied that the foreign body was localized by X-ray and ophthalmoscope, and he went through that part of the sclera which he calculated was nearest to it.

Von Hippel-Lindau's Disease.

T. S., male, aged 43.

Sent for examination on account of giddy attacks and family history of Lindau's disease.

R. retina shows a large area of hæmangiomatosis in its temporal periphery, and waxy degenerative changes along the upper nasal veins. Four small saccular arterial dilatations may be seen. R.V. $= \frac{6}{12}$.

The C.N.S. shows no definite abnormality. Six near relatives have been affected with different variations of the von Hippel-Lindau syndrome.

This man first came to me while his brother was convalescing from an operation for a cerebral cyst. While he was attending his brother he began to have giddy fits. I then discovered this area in his eye and started to investigate his pedigree, which is a very remarkable one. He is an ex-army boxing champion who has received a good many blows, and he had a blow in his eye with a stone, so that a question arose whether this condition was traumatic or congenital. He has a small central scotoma and a field defect corresponding to the hæmangiomatous area. The family history is interesting. His mother died of a stroke at the age of 64 ; there was no post-mortem. Her first child, a son, died of " a cyst on the brain ", aged 42. The second child, a daughter, died of a " stroke ", aged 46. The third child, a son, has von Hippel-Lindau's disease, as has this patient, the fourth child, though he has nothing definite yet in the central nervous system. His only living sister, the fifth child, has a curious condition of the eyes. One eye is normal and has a full field with $\frac{6}{6}$ vision, except in the upper temporal quadrant where there is a complete scotoma. The field in the other eye is normal. She has been like that for many years. A nephew of this patient has just died with von Hippel-Lindau's disease. An aunt who is still alive started to have cysts in both breasts at the age of 38, and now has serious abdominal trouble, possibly cysts in the kidney. She had cataracts in both eyes and was operated on unsuccessfully. She was told that this was because there were scars at the back of the eyes.

All the available post-mortem reports from different hospitals have not yet been obtained. Consequently the family history is largely surmised, but there certainly seems enough to classify the condition.

Congenital Dislocation of Lens causing Acute Glaucoma.—Shown by ANTHONY PALIN, F.R.C.S.Ed. (for R. BUXTON, M.B.).

P. R., aged 19.

17.1.39 : History of acute pain R.E. Acute glaucoma present caused by dislocation of lens forwards and partially into A.C. Medical treatment unavailing. Operation under evipan anæsthesia. Lens removed, prolapse of vitreous as section completed, corneo-scleral suture—uneventful recovery.

$$\text{R.V. } \bar{c} \frac{+ \text{ 9·25 D. sph.}}{+ \text{ 1·5 D. cyl. axis 25}} = \tfrac{6}{18}.$$

L.E. shows lens dislocated down and in

     L.V. $+$ 11·0 D. sph. $= \tfrac{6}{18}$. $+$ 15 D. sph. $=$ J 8.

This interesting boy was wearing a few years ago -25 D. spheres and got $\tfrac{6}{18}$ vision. He was checked carefully by a London ophthalmic surgeon. But now his refraction has changed from the high $-$ to about $+$ 11 in each eye. The result in the right is, of course, due to the extraction. In the left eye this is due to steadily increasing subluxation of the lens.

The vision in both eyes is still $\tfrac{6}{18}$.

Mr. L. H. SAVIN said that he thought Dr. Buxton was to be congratulated on this case which he noted occurred in a patient with arachnodactyly. Some years ago he had a similar case brought to him in hospital, and the lens was removed, but the result was not as good as that shown in the present instance. Three months later the patient's sister turned up with the lens dislocated in the anterior chamber. He found that there were nine children in the family, all with arachnodactyly and dislocated lenses.

The following cases were also shown :—

By A. E. ILES, F.R.C.S.

     Congenital Cataract and Congenital Coloboma of Lens, Up and In.
     Choroiditis with Traction Bands.
     Secondary Cataract and Iris Anomaly.
     Retinal Mole.

By B. GLUCK, F.R.C.S.Ed.

     ? Congenital Macular Anomaly.
     Secondary Optic Atrophy with Peripheral Pigmentary Disturbance Simulating Retinitis Pigmentosa.

By RAMSAY GARDEN, M.B.

     Aniridia.
     Congenital Colobomata of Irides and of Fundi including Optic Discs.
     Ectopia of Pupils and Lenses : Discoria.

By ANTHONY PALIN, F.R.C.S.Ed.

     Y-Shaped Cataracts.
     Deep Guttate Keratitis.
     Blood-staining of Cornea.
     Vossius' Ring.
     Filamentary Keratitis.

By ANTHONY PALIN, F.R.C.S.Ed., for R. BUXTON, M.B.

     Monocular Diplopia.

A Case of Bilateral Keratitis and Cyclitis Due to Filaria (*Onchocerca volvulus*) Infection in a European from Kenya

By A. H. Levy, F.R.C.S.

This patient has been living in the Kakamega district of Kenya for ten years as Senior District Commissioner and came home on leave early in 1937. He consulted Dr. A. L. Gregg (who at that time was acting for Dr. Manson-Bahr) about his general health and at the same time complained of irritation and sandy feeling in his eyes.

I saw him for the first time in March 1937, for what appeared to be a very chronic conjunctivitis. I was told at that time that he had a high eosinophilia suggestive of a filarial infection, but that that had probably nothing to do with the eye condition. His vision with a small correction was right $\frac{6}{5}$ and left $\frac{6}{9}$. In spite of a careful examination the eyes themselves appeared quite normal.

The usual treatment was adopted and by June 1937 the conjunctival condition had improved somewhat. His general condition had also improved so that he was allowed to return to Kenya in September 1937.

He came back to England in January 1939, and stated that his eyes had remained inflamed the whole time. Examination now revealed quite a different state of affairs. The conjunctival injection still remained, but there was keratitis and cyclitis.

The infiltrations into the cornea, as you will have seen, are present at varying levels in the corneal substance from just behind Bowman's membrane to just anterior to Descemet. They occur at the periphery as small foci of greyish colour and where these have coalesced form larger plaques, the larger area being more in the centre of the cornea. There are fine branching vessels from the limbus invading the anterior layers of the cornea (fig. 8, *Am. J. Trop. Med.*, 1938, **18**, No. 1, 64).

On the posterior surface there were very numerous spots of K.P., some of them rather large and white, but there were also present fine pigmented spots of K.P. There was, of course, associated with this the usual circumcorneal injection, but there was very little tenderness over the ciliary region and the patient did not complain of any pain. The chief disability was a persistent and troublesome photophobia. The iris did not appear to be involved at all. Vision still remained at right $\frac{6}{5}$, left $\frac{6}{9}$ or $\frac{6}{12}$.

No gross vitreous opacities could be made out, nor was there any limitation of the field of vision. The importance of this latter observation is that in some cases of this type of infection the anterior parts of the eye escape, but there is a severe retino-choroiditis which occasionally leads to a rapid optic atrophy and complete blindness. In recent years this condition has received the name of "Sudan Blindness" in Africa from the fact that it was first recorded in that country in cases of infection by *Onchocerca volvulus*.

In spite of frequent and careful examination with the slit lamp no microfilariæ were ever seen either in the cornea or aqueous.

The only eye treatment adopted was atropine and hot bathing and under this the ciliary injection diminished—in fact almost disappeared and the K.P. diminished very much, but as you will have seen there is still a considerable amount present.

For some time the eye lesions were held to be quite independent of the general infection. Then as the association of the two conditions was found to be very frequent it was suggested that the eye changes were due to some toxin liberated into the circulation which affected the eye.

An expedition into Guatemala and Mexico from the Department of Tropical Medicine of Harvard University in 1930 and 1931 succeeded in demonstrating the presence of microfilariæ in the ocular tissues, conjunctiva, cornea, ciliary body, iris and choroid, and even rarely in the vitreous, so that the case can be considered as made out that here we have an inflammation of the tissues of the eye caused by this organism.

From the way the eye reacts it is obvious that there can be very little toxic effect. The mere presence of actively moving microfilariæ would be sufficient to cause the symptoms found and, furthermore, as these microfilariæ die their remains must act as foreign bodies in the cornea and other tissues and cause a corresponding reaction.

Discussion.—Dr. P. MANSON-BAHR: It must be rather an experience for ophthalmologists to be introduced to the mysteries of helminthology as in this particular case. The group of Filaridæ which we are concerned with are known as Onchocerca. This is a large group of which only one species (*Onchocerca volvulus*) is known to infect man, though somewhat similar ones are found in cattle (*O. bovis*), and in India there is a species which infects native oxen (*O. gibsoni*), and in Africa another which inhabits the intima of the aorta of the buffalo, and yet another peculiar to horses. But in none of the animal infections are ocular signs or symptoms apparent as in the case of the human species.

These filariæ have been known for many years, though *Onchocerca volvulus* was at first thought to be confined to West Africa, where it produces in the natives nodules on the skin having very much the appearance of sebaceous cysts, but later it was discovered to be prevalent in Panama and Guatemala, especially in districts famous for coffee plantations. There, at an altitude of 2,000 to 3,000 feet above sea-level, nearly all natives exhibit nodules on their heads and necks.

The Onchocerca that occurs in South America was regarded by Brumpt as a separate species and called *O. cæcutiens*. There has been a good deal of controversy as to whether this is distinct from that which is found in West Africa, but probably the latter was imported into South America in the course of the slave trade.

The female is a long worm, 20 to 35 cm. (8 to 14 in.) in length, and so inextricably coiled in spirals that it is almost impossible to extract it from the tumours. The male is an insignificant creature, 40 mm. in length, and averages only one to about five females. Generally both sexes inhabit nodules in the skin. Apparently at first they are capable of wandering about in the subcutaneous tissues before settling down to form a nodule. The female produces a large number of embryos (or microfilariæ) which enter the substance of the cyst and then wander into the surrounding tissues. Whether this wandering takes place by way of the lymphatics, or whether they burrow through connective tissues is not known.

In recent years it has been shown that these embryos are to be found in all parts of the body. In the case under review they were demonstrated by taking a Thiersch graft section of the skin of the forearm after a hot fomentation had been applied as it has been proved that the embryos are thermotropic, and this knowledge adds greatly to the ease with which a positive diagnosis may be made. In the neighbourhood of an Onchocerca nodule, it suffices to snip off a piece of skin and place it in saline solution, centrifuge, and then pipette off the bottom layer. The active wriggling microfilariæ can then be seen under the microscope.

The embryo is distinguished from other human microfilariæ by not having a sheath, by its globular head, by its heavily stained nuclei. It is about 300 μ in length. The embryos are said to travel swiftly at the rate of 1 cm. a minute in the skin.

The association of this onchocerciasis with blindness has been very gradually elucidated. At first it was believed to be so by the natives of Guatemala. It was then described by Robles and by De La Torre, a Mexican ophthalmologist, in whose country a large amount of blindness is also ascribed to this parasite. This theory was at first entirely disbelieved, and the Germans sent out an expedition to Guatemala and concluded that the parasite had nothing to do with these eye lesions at all. Then came the expedition of Strong and Sandground, of Harvard University, to Guatemala, and they proved definitely that *Onchocerca volvulus* was the

cause of blindness. In 1932 a similar expedition went to the Katanga Province of the Belgian Congo, where, at the height of about 2,000 to 3,000 feet above sea-level, the population of whole villages was found to be blind. It is estimated that in this Province alone 10% of the people are blind from this cause. The reason for the prevalence of this parasite in that district is due to the fact that it is carried by a small black fly (*Simulium damnosum*), known popularly as the "buffalo gnat". In many of the plantations of Guatemala life is made absolutely intolerable by a similar pest (*Simulium mooseri*). Natives are actually driven out from their villages by these flies. Twelve years ago Blacklock proved that this genus of fly definitely transmits *O. volvulus*. It sucks the lymph from the skin and in so doing ingests the embryos. The embryos develop inside its body and presently pass into its proboscis, from which they are ejected again into man and thus undergo the full life cycle. This, however, is not the end of the story, because this parasite produces definite lesions of the skin—a sort of skin erysipelas. The patient who has been shown to-day has had various curious skin lesions, such as puffy swellings of the hand, which are probably allergic manifestations of the toxins given off by the parasite. An enlargement of the pinna of the ear is known in Guatemala as "*Erisepela de la Costa*". Sometimes also elephantiasis of one leg appears, and very often hydrocele, in which adult worms have been found. A lichenoid condition of the skin is also frequently encountered.

The demonstration of living microfilariæ in the eyes has been made on several occasions by different observers. The most reliable observation is by Boase in Uganda in 1935, who, using the slit lamp, was able to see the microfilaria moving across the aqueous humour in a blind school teacher. From Mexico it has also been reported that the embryos have been seen in the internal chamber of the eye, and the same observation has been mentioned in the Congo by Hissette, and also on one occasion the adult worm has been seen there. Two observers have stated that patients complained that they could see before their eyes the movements of the parasites—I presume in that case they were the embryos.

Unfortunately in the case shown to-day we have been quite unable to find any of these subcutaneous tumours. Some commonly seen vary from the size of a split pea to that of a pigeon's egg. It is said among the natives in Guatemala and also in Mexico that, if these tumours occur on the head and are removed surgically, the eyesight of the patient is much improved.

The whole question of onchocerciasis deserves special emphasis at the moment because of the opening up of the mining regions of Kenya to the white man. On searching the natives for skin microfilariæ it has been found that 40% of those employed on the mines of Kakamega are infected.

Finally comes the question of treatment, which usually consists of the excision of the tumours. Quite a number of people have claimed that drugs will extirpate the parasite. I only wish they would. Antimony has been suggested, and it has been claimed, especially in the recent case in Liverpool who came from South America, that intravenous injections of tartar emetic will kill off the parasite. It is doubtful whether it touches the adult worm, even if it kills the embryos, and it does make the patients rather ill. It appears in the present case that this drug may actually cause an increase of the iridocyclitis and it is therefore a risky procedure. In other filarial infections of man it is known that the filariæ have a definite life span, they live from seven to ten years and then die from natural causes. So we think that in the patient shown it will be much better to leave it to climatic causes and to his general health. We do not think he is going to become blind, and probably he will get much better.

Mr. W. H. McMULLEN said that this had been a most interesting communication. Two years ago he came across a young Indian student in the anterior chamber of whose eye he saw some microfilariæ. He showed that case before the Section twice about eighteen months ago. On the first occasion no larvæ were visible, but the second time there were several in the anterior chamber, clearly visible with the slit lamp. That was an infection with *Filaria bancrofti*. It was only on looking up the literature that he had learnt about Onchocerca infection, the most important form of filarial infection from the ophthalmic standpoint. As far as he knew, the case shown by Mr. Levy and Dr. Manson-Bahr was only the second one of the kind reported in this country. The first was published by Adamson in the *Lancet* in 1938. In that case the

living microfilariæ were seen in the cornea. The practical importance of these cases was that ophthalmologists must now be on the lookout for this type of infection in cases of keratitis and uveitis of doubtful ætiology, if the patients had lived in parts of the world where these parasites were prevalent.

Mr. HUMPHREY NEAME asked whether he was correct in assuming that the large lumps shown on the heads of natives in the photographs were due to the adult worms and the lichenoid appearance of the skin was due to the embryo, but also that the embryo was present in abundance in an apparently normal skin, as in the case demonstrated. It was interesting to have another parenchymatous keratitis due to an organism of this sort. There was such a keratitis due to syphilis, to tuberculosis, and to leprosy in man, and in animals in trypanosomiasis, trypanosomes were to be seen in sections of infected cornea, and similarly in distemper in dogs, though in the latter case one had not, of course, microscopic evidence of the presence of the virus in the cornea itself, but it was to be presumed that the corneal condition was started off by the presence of the actual infecting organism.

Dr. F. MURGATROYD said that this paper was particularly valuable to the Section of Ophthalmology. Ophthalmologists might well be the first to be consulted by patients in this country because the eye symptoms were often the first troublesome feature of the infection and might arise some time after the patient had left the tropics. Besides those recorded in this country such cases had been reported from Germany, France, and Belgium.

Contrary to original belief more precise observations had shown that in Africa nodules on the head were not infrequent, although in Central America tumours in this region did appear to be more common. The localization of the tumours was of some significance in so far as it influenced the density of the migrating microfilariæ in the tissues of the eye. It was to be remembered, however, that, as in the present case, demonstrable nodules might be absent.

In an endeavour to determine whether the eye lesions were due to some toxin excreted by the worm or were due to the trauma produced by the migration or death of the larvæ in the ocular tissues, Hissette, in the Congo, carried out certain experiments. He injected into the tissues of the head over a period of days extracts prepared from adult worms but failed to produce any ocular manifestations, although there were strong local reactions at the sites of the injections. In other experiments he injected suspensions of microfilariæ into the cornea and watched their progress with the slit-lamp, but he could not detect any damage following the migrations of the larvæ. This was perhaps not strictly comparable with what happens naturally, as long-standing infections might produce an allergic condition and sensitized tissues might react much more violently to small amounts of filarial protein than normal tissues ; in such allergic states dying and disintegrating larvæ might induce very considerable focal reactions. If this were so it might have some bearing on treatment. Following a suggestion of Dr. Fairley the present speaker had, in other filarial infections, seen benefit follow attempts at desensitization with progressively increasing daily doses of filarial antigen. This treatment had been given to patients suffering from allergic filarial manifestations such as Calabar swellings, pruritis and urticaria, with considerable diminution in the discomfort and in the number of attacks. In these patients typical allergic attacks were sometimes produced by too large doses and if the treatment were tried in ocular onchocerciasis the injections would have to be given with considerable caution because of the possibility of inducing focal reactions leading to the very condition it was being attempted to avert.

Dr. MANSON-BAHR said that various observers had discovered other filariæ in the eye of man. *Filaria bancrofti* had been found there, though with great rarity. He remembered reading the case of the Indian student brought forward by Mr. McMullen, but it did not follow, because the embryos of *Filaria bancrofti* were found in the eye, that it proved that this was really part of the life history of the parasite ; it was merely an exceptional occurrence. There were islands in the Pacific where from 90 to 100% of the inhabitants had got *Filaria bancrofti*, and yet there was no evidence at all that the eye lesions found there were due to the parasite. He had seen Europeans in various regions who were known to have been infected with *Filaria bancrofti* for thirty or forty years, and yet they had perfectly good eyesight.

On the question of treatment, he was very glad to have heard Dr. Murgatroyd's remarks on this subject, because he himself had thought of this de-sensitization procedure, and some of his

cases of *Loa loa* had been submitted to it.   A very bad case which he had last summer was greatly benefited thereby.   The eye-worm of West Africa (*Loa loa*) did not apparently do any harm in the eye.   In China Thelazia, a cattle parasite, had occasionally been seen in the eye of man.

The reason why the patient who had been shown did not exhibit any nodules was very difficult to explain.   Yet it was evident that there must be several adult worms in his body. The investigation of the Harvard expedition showed that when eye lesions were present the adult worms were somewhere in the vicinity of the head or neck.   There was no evidence to show that if there was a colony of adult worms in the arm, for example, the embryos would wander up to the level of the eyes.

Section of Otology and Section of Laryngology

COMBINED MEETING

HELD AT SHEFFIELD, JUNE 16 AND 17, 1939.

OTOLOGICAL SESSION

Chairman—E. D. D. DAVIS, F.R.C.S. (President of the Section of Otology)

DISCUSSION ON EAR DISEASE IN THE CHILD

Mr. A. G. Wells: The treatment of aural disease in children is mainly concerned with the treatment of hearing defects and suppurative disease of the middle ear. Most of my experience with children has been gained in the service of the London County Council.

I do not propose to discuss in detail the many treatments for suppurative otitis media and defective hearing that have been used in the London County Council's service, but I would like to concentrate on certain methods that have given consistently good results over the course of many years.

For several years testing the hearing of London school children by means of the gramophone audiometer has become a routine measure. There are two objectives in this, (1) the detection of hearing defects in one or both ears, which are frequently not discovered by routine school medical inspection, especially when the defect is unilateral ; so that treatment may be instituted as early as possible, and (2) to discover whether any of these children should be removed to another educational environment.

During the past four years between 200,000 and 300,000 children have been tested in this way in the London County Council area.

Clinical examination of children who fail in their audiometric test reveal the high incidence of nasal ill-health and experience has taught us that if we improve the condition of the nose, many cases of defective hearing are relieved, especially in the early stages.

A treatment which I have employed on a somewhat extensive scale is diastolization. This consists of the introduction into the nose of hollow rubber bougies. They are triangularly oval in section, are curved to take the deviation of the nasopharynx, and taper from the larger open end to the smaller blind end which is introduced into the nasal canal. To the open end is attached a pneumatic bulb by means

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of a glass connexion. The bougie is passed into the nasal canal until the blind end projects through the posterior nares into the nasopharynx. The pneumatic bulb is then attached to the open end of the bougie and a to-and-fro movement of the bougie in the axis of the canal is initiated, combined with an alternating compression and relaxation of the bulb, which thus conveys a rhythmic pulsatile impact to the nasal structures. There are various modifications of this technique but the basic principles are the same in each. Although the action of diastolization is not fully understood, it is certainly not a mechanical dilatation. It appears to diminish the turgescence by stimulation due to contact, thus causing retraction of the mucous membrane and the underlying soft tissues. It also brings about a secretion of mucus and hence a glandular disgorgement. Briefly, it removes the congestion and thus re-establishes natural ventilation. By its action on the nerve endings of the nasal mucosa it awakens

Diastolization bougie.   (Mayer and Phelps.)

the blunted sensitiveness of the air vestibule and assists in respiratory re-education. It is also believed to act reflexo-therapeutically on other organs. The nasal respiratory flow which can be measured with Peck's " masque manometrique ", and which normally should be about 1·75 litres per second, but is always reduced in these nasal conditions, generally registers an increased respiratory flow after diastolization.

The treatment has been used extensively in France, especially for children, and great success is claimed for it. It is employed in cases of defective nasal respiration due to congestion and swelling of the nasal tissues, such as hypertrophic rhinitis and conditions secondary to these, e.g. mouth breathing, Eustachian catarrh and catarrhal deafness. It is also helpful in sinusitis, otorrhœa and other conditions. I have been using this treatment since 1926, and have satisfied myself with its usefulness in suitable cases. It is used in all our special ear clinics, but I propose to give you the results of this treatment as carried out in our audiometric units only.

2,191 children who were failures in their audiometric test and who had nasal conditions which were considered to be the cause of their hearing defect were diastolized. After treatment 1,257 or 57% had sufficiently improved hearing to enable them to pass their final test, a further 535 or 24% were improved, but not sufficiently to pass the test, and 399 or 18% registered no improvement (Table A).

CHILDREN TREATED BY DIASTOLIZATION. TOTAL No. 2,191.

Total Children 2,191.

	Passed test (G.A.)	Improved	Not improved
A	1,257 (57%)	535 (24%)	399 (18%)

81%

Diastolization only 1,050.

	Passed	Improved	Not improved
B	676 (64%)	225 (21%)	149 (14%)

85%

Diastolization + Nasal Applications 404.

	Passed	Improved	Not improved
C	226 (56%)	88 (21%)	90 (22%)

77%

Diastolization + Inflation 567.

	Passed	Improved	Not improved
D	292 (51%)	165 (29%)	110 (19%)

80%

Diastolization + Local Treatment for Otorrhœa 152.

	Passed	Improved	Not improved
E	50 (33%)	53 (35%)	49 (32%)

68%

Diastolization + Removal of Tonsils and Adenoids 18.

	Passed	Improved	Not improved
F	13 (72%)	4 (22%)	1 (5%)

94%

A certain number of the 2,191 children had diastolization only, while others had diastolization plus nasal applications of one kind or another ; diastolization plus inflation ; diastolization plus local treatment for otorrhœa ; diastolization plus operation for removal of tonsils and adenoids. In order to compare the results of those who had diastolization only with those who had diastolization and other treatment, I have divided these into five groups.

Table B shows 1,050 children who had diastolization only. 676, or 64%, improved sufficiently to pass final test ; 225, or 21%, improved but not sufficiently to pass the test ; 149, or 14%, were not improved. This table shows that 85% of the children improved.

Table C shows 404 children who had nasal applications in addition to diastolization.

226, or 56%, of these improved sufficiently to pass the test ; 88, or 21%, improved but not sufficiently to pass ; 90, or 22%, were not improved. This table shows that 77% improved.

Table D shows 567 children who had inflation in addition to diastolization. 292, or 51%, improved sufficiently to pass ; 165, or 29%, improved, but not sufficiently to pass ; 110, or 19%, were not improved. This table shows that 80% improved.

Table E shows 152 children who had local treatment for otorrhœa in addition to diastolization. 50, or 33%, improved sufficiently to pass ; 53, or 35%, improved

but not sufficiently to pass ; 49, or 32%, were not improved. This table shows that 68% improved.

Table F shows 18 children who had an operation for removal of tonsils and adenoids in addition to diastolization. 13, or 72%, improved sufficiently to pass ; 4, or 22%, improved but not sufficiently to pass ; 1, or 5%, showed no improvement. This table shows that 94% improved.

These tables suggest that diastolization alone gave at least as good results as diastolization plus any of the additional treatment employed.

No value can be attached to Table F as the numbers are too small. These figures are compiled from the returns of four otologists. The number of séances in general varied between 12 and 24 per child at the rate of two a week.

I should like to make a short reference to another method of treatment I have employed, viz., chlorine ionization.   This is the application of the Cl ion over the mastoid area under the negative pole and raising the amount of current passing to 10 ma. by stages according to the reactions of the patient.   Ten minutes treatment is given to each ear.

It has been suggested that fibrosis which results from tubo-tympanic inflammation, and leads to partial or complete occlusion of the eustachian tube, to thickening and adhesions in the tympanum and to fibrous ankylosis of the articulations of the ossicles, is resolved by the passage of the current. But just how this operates I do not know. It is quite certain that the Cl ion cannot reach the tympanum or Eustachian tube. Possibly the nutrition of the cells is altered by the replacement of certain ions in the cells by other ions in the tissue fluids. Whatever be the real explanation, the fact remains that a considerable percentage of cases of defective hearing of middle-ear type show various degrees of improvement. Further, in some cases tinnitus is also relieved.

PATIENTS WITH DEFECTIVE HEARING TREATED BY CL IONIZATION.

	Diagnosis	No. of treatments	G. A. test before treatment	G.A. test after treatment
(1)	Right mastoid operation	24	63 d b level (R.)	51
	Left middle-ear catarrh	24	41 ,, ,, (L.)	32
(2)	Chronic middle-ear catarrh	12	41 d b level (R.)	38
	,, ,,	12	41 ,, ,, (L.)	32
(3)	Chronic middle-ear catarrh	36	57 d b level (R.)	45
	,, ,, ,,	36	18 ,, ,, (L.)	12
(4)	Chronic middle-ear catarrh	18	63 d b level (R.)	54
	,, ,, ,,	18	57 ,, ,, (L.)	48
(5)	Chronic middle-ear catarrh	36	60 d b level (R.)	42
	,, ,, ,,	36	54 ,, ,, (L.)	42
(6)	Chronic middle-ear catarrh	15	24 d b level (R.)	18
	,, ,, ,,	15	38 ,, ,, (L.)	32

I have not been employing this method long enough to be able to state whether the improvement is maintained. Nor are the numbers sufficient to make an analysis of cases of any value. The most that one can say at present is that there is a prima facie case for this treatment in some cases of middle-ear deafness.

In catarrhal conditions of the nose, ear and throat local treatment should be combined with general treatment, particularly an increase in the raw foods, fruit and vegetables, and a corresponding limitation of carbohydrates.   Catarrhal conditions are seldom, if ever, strictly localized to the upper air passages.

Suppurative disease of the ear is predominantly of the chronic type in London school children, and it is likely to remain so until adequate arrangements are made for the efficient treatment of the pre-school child. The Ministry of Health Circular

1337a, recommending local authorities without aural services to take advantage of the service of another authority with one, had a poor response in London.

The methods of treatment I have employed in chronic suppurative otitis media are many, but outstanding among them is zinc ionization. I have been using this since 1918, and the success I have obtained has eclipsed all other forms of treatment.

It would be well to define what we mean by *chronic* suppurative otitis media. I think it may be described as the response of the tissues to irritation of a septic fluid in contact with them.

When the inflammation in acute suppurative otitis media is subsiding the discharge diminishes, but, remaining in the ear, becomes infected and irritates the tissues.

The efficiency of zinc ionization when used for sepsis alone in an accessible position points the way to a rational line of treatment.

If there be something in addition to sepsis, remove that something ; if the position of the sepsis be inaccessible, operate to gain access.

I have found consistently that in cases of uncomplicated tympanic sepsis, zinc ionization has given round about 90% of successful results, most of them requiring only one, but some two, administrations. The figure should be 100% rather than 90%, the smaller figure being due I think to error in the original diagnosis of the cause of chronicity, which is not always easy or even possible to make at a first examination. Friel has obtained similar results.

It is to Professor Le Duc of Nantes, we owe this method of treatment. Ionization, or galvanism, was used occasionally before his time, but the rationale was not properly understood. In this country Dr. A. R. Friel has been a pioneer in the treatment of chronic suppurative otitis media by zinc ionization, and it was through him that I became interested in 1918 and I have employed this treatment ever since.

The secret of the success of zinc ionization in the treatment of suppuration is that there is antisepsis without irritation.

Zinc ions are introduced when the current flows. In an electrolytic cell a stream of positive ions move from the positive electrode to the negative, and a stream of negative ions in the reverse direction. In ionization treatment ions in the tissues are *replaced* by ions introduced from the solution, i.e. there is REPLACEMENT not *addition*.

If a lotion is used without passing a current, its penetrating power is almost nil if it is very weak, while if it is strong, irritation and exudation occur because not only are both positive and negative, i.e. the zinc and the SO_4 ions introduced at the same spot, but there is also an alteration in the value of the ionic content of the tissues— here there is *addition*, not *replacement*. In zinc ionization, zinc alone is introduced under the positive electrode ; SO_4 is not introduced. The zinc combines with the albumin of the tissues and fluids of the body to form a precipitate and so goes out of action as far as subjacent tissues are concerned. They are coated with a precipitate and this precipitate is a bad culture medium for bacteria, and protects the subjacent tissues from irritation.

In this method the most important thing, after diagnosis, is to prepare the ear properly for the actual ionization. Unless this technique is carried out efficiently, the result will be failure, however suitable a case may be.

Many cases of complicated tympanic sepsis can be made suitable for the treatment. For example, cases of tympanic sepsis complicated by granulations or polypi produced by the irritating effect of discharge and not caused by disease of bone, will clear up by zinc ionization after removal of the granulations. In the after-treatment of mastoid operations, this treatment is very helpful. The two factors most needed for healing are sterilization of the area and physiological rest, and there is no treatment which combines these two factors so completely as zinc ionization. A minimum of interference with the ear is necessary, generally no more than once

a week. Furthermore, it is not always possible on first seeing a case to decide what is the cause of chronicity. One administration of ionization is often helpful in coming to a correct decision.

In acute inflammation of the middle ear I treat most cases if seen early enough by sending them to bed with instructions to rest in the semi-recumbent position, with some garment, preferably a flannel one, covering the head and face completely and hanging loosely over the shoulders and chest. This is kept on for forty-eight hours and only raised from the face when nourishment is taken, and when the hearing
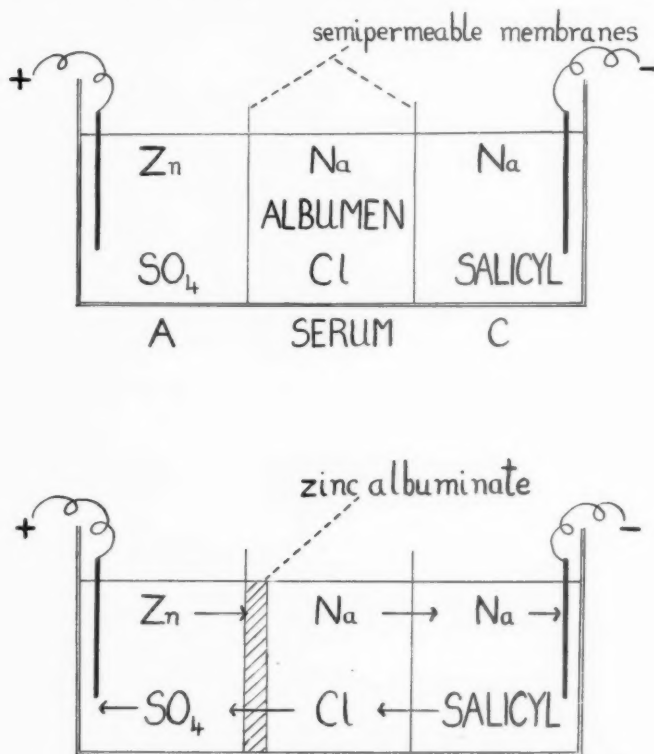
Diagram indicating the direction of movement of different ions in a vessel divided into three compartments by semi-permeable membranes when an electric current is flowing. It shows that there is replacement of ions but no addition.

is tested which should be done two-hourly. The record of the hearing is a valuable indication as to what is happening in the tympanum. Two small holes may be cut in the garment opposite the eyes so that the patient may use them if and when he desires to interest himself in his surroundings. In addition I use sometimes instillation of glycerine and carbolic, otalgan or other drops, but the important thing is the continuous heat caused by the head-covering resulting in hyperæmia and as large a supply as possible of white cells to combat the infection.

Many ears have been spared a perforated drumhead following this treatment, and although it is difficult or even impossible to prove, I think the result has been due very largely to this technique.

I have treated a small number of acute ears both before perforation of the tympanic membrane and after perforation with irradiation from the Kromayer water-cooled lamp with rapid resolution of the condition.

The number of cases, about nine, is too small to make any accurate assessment of its value in acute otitis media, but I have used the Kromayer lamp in very many cases of radical mastoids in process of healing when progress has seemed to slow up, and the irradiation has almost invariably given a fillip to the tissues and accelerated the healing.

It is now recognized that sinus disease is much more prevalent in children than at one time was supposed, and that this is the cause of a certain number of cases of aural suppuration, and defective hearing.

I have been using Proetz displacement method in some of these children, but I have not yet been able to satisfy myself as to its value.

Dr. Phyllis Kerridge: An estimate by the Board of Education of the number of school children in England with defective hearing amounts to roughly 80 per 1,000 children in average school attendance, that is about one-third million in all. Happily for the children and their teachers about 95% of such children have defects which are so slight that the term deafness is not a suitable term to apply, and the children cannot be said to suffer from any educational handicap. But the matter is not nearly so fortunate for the administrators of the public health, as probably 98% of these children need medical attention over a long period, for the sake of their general health, and in order that they may not grow into deaf adults. The majority of the defects of hearing in these children are due to chronic middle-ear disease.

Why should middle-ear disease be so common among the elementary school children in this country ? Scarlet fever and measles are responsible for a number of the cases, about 12% of the patients in fever hospitals with these diseases developing ear complications. As the infection of the ear is usually due to streptococci, we await with interest the new figures which will soon become available showing the effect of the introduction of the sulphanilamide drugs.

In an attempt to define more precisely the factors underlying chronic middle-ear disease in children, I have tested the hearing of over 5,000 school children throughout Great Britain, in various social groups. Defective hearing was about four times as common on the average among the elementary school children as it was among children at schools at which fees were paid by their parents, and over 80% of all the cases were due to middle-ear disease. Among the better group there was not a single case of chronically discharging ear, most of the failures in this class being very slight residual effects of past acute disease, and only amounting to 2·8% of the children.

The average failures in the poorer group were 12%, and the worst figures were as high as 22%, these being recorded in a well-housed, but under-endowed, orphanage, situated in the poorest part of a small town. It is interesting to note that there was little difference between the boarding and the day schools in either group. Nor has climate as much effect as was expected. The average annual rainfall of the East Anglian town tested is only half that of the town near Manchester, yet both these, and a housing estate near London gave about the same failure figure.

Some of the districts which were investigated were those in which dietary surveys had been carried out by workers attached to the Ministry of Health, or the Rowett Research Institute, Aberdeen. I am indebted to them for their co-operation, and for

permission to see and to use their results prior to their own publication of them. The question of the nutrition of the children is too lengthy a one to retail in full, but it may be said that in the two places at which the worst figures were obtained the diet was deficient in total calorific value, in vitamins A and C, and in protein.

It is reasonable to expect that the incidence of chronic middle-ear disease will diminish with improvements in social conditions, especially since it has been shown that the diet of English people is usually adequate when money is not scarce.

The Ascertainment of Deafness and Ear Disease in Children

By T. C. LONIE, M.B., D.P.H.,

School Medical Officer, County of the Isle of Ely

Introduction

THE purpose of the present paper is to examine the findings in relation to deafness and ear disease of different forms of examination ; to discuss the reasons for disparities in these findings ; and to suggest some possible remedies.

General Scope and Findings of Investigation

During the summer of 1938, Dr. P. M. Kerridge of University College carried out a survey of the hearing of children attending certain elementary schools within the administrative county of the Isle of Ely. All the schools with one exception were situated within the borough of Wisbech, a small town of 15,000 inhabitants set in a rural area, where most of the population is engaged in agriculture, and housing conditions are frequently poor. The hearing test was the usual gramophone audiometer one, with a final examination of failures by Dr. Kerridge, using a pure tone audiometer. Of 1,350 children of ages ranging from 7 to 14 years, 144 or 10·7% failed to pass the test ; though, owing to absence, four of these did not have a second chance of passing. (These figures are slightly different from those quoted in Dr. Kerridge's paper, probably due to some slight difference in the enumeration of the failures. The difference is, however, insignificant.) These failures were all invited to attend the school clinic for a special examination with a view to discovering, and, if possible, remedying the cause of the deafness. In addition the school medical record cards of the failures were examined in order to ascertain whether there had been previous record of ear defect. Of the total failures, 84 reported to the clinic, and 60 did not attend for various reasons. With such a large proportion of absentees the question arises as to whether only those who were conscious of ear disease attended, or whether on the contrary those with ear disease which had been previously neglected simply ignored the invitation and whether, perhaps, some of those who were already under the care of their own doctor did likewise. It would be extremely difficult to arrive at the exact truth regarding these failures, but we did find that 11 of them had previous records of ear trouble and eight of mental backwardness. As a working hypothesis perhaps we may assume that the cases which did not attend were unselected and contained a fair proportion of children both with and without disease, and that the 84 were equally unselected.

Dr. Kerridge classified the failures as shown in Table I below.

TABLE I.—POSSIBLE CAUSE.

Total No. examined	Failures	Wax	History and test indicating otitis media	Test only indicating otitis media	Mental defect
1,350	140	21	78	26	15

(Omitting the cases who were absent from the second test.)

With this may be considered Table II which shows the results obtained from the school médical records.

TABLE II.

Failures in audiometer tests	Previous medical records available	No. of cases in which ear defects were previously noted		Previous history of mental defect or backwardness
		Deafness	Otitis media	
144	125	20	18	12

The 84 children who attended the special clinical examination were carefully investigated by my two assistants Drs. F. E. Crawley and M. V. Joscelyne, and their findings are set out in Table III below.

TABLE III.

Number of children receiving special examination	84
Number having abnormality of drum (14 actual perforations)	30
Number with history of otorrhœa	26
Number with otorrhœa at inspection	10
Deafness due to mental backwardness	2
No cause for deafness discovered..	7
? failure due to distraction	4
Wax noted in ear at examination	34

Incidence of Otitis Media

To deal with the findings in detail we may look first of all at those for otitis media. Of the 144 failures Dr. Kerridge found a history (confirmed by test) of otitis media in 78 or over 55%, and indication by test only of a further 18%, a total of 73% of the failures, and 7·7% of the total children examined.

In our own examination of the failures, we found 30 out of 84 with some abnormality of the drum, and 26 with actual history of otorrhœa. To the 30 should be added two cases where the drum was not seen, but where there was otorrhœa present and of long standing. The incidence of otitis media is therefore 38% of the 84 failures, and is equivalent to $4\cdot1\%$ of all the children examined. The number of children whose medical record cards showed a previous history of otitis media was 18, or $1\cdot3\%$ of the total number examined. This curiously enough is much higher than the figure for the whole county which was, in 1938, 0·55%. It will be noted that in four cases of the 30 having an abnormality of the drum there was no previous history of otorrhœa. These and no doubt other cases where no such abnormality was noted, almost certainly represent cases of chronic middle-ear catarrh where there is no discharge and which yet causes deafness of the middle-ear type.

We have therefore figures which, for the children under discussion, vary from 7·7% to 1·3% as a measure of the incidence of otitis media. Such a disparity requires some explanation.

Incidence of Defective Hearing

Let us turn to the findings for defective hearing. As previously said, Dr. Kerridge found that 10·7% failed to pass the audiometer test. I have not calculated the number of children whom my assistants considered to have defective hearing at the special examination, because while the majority of those seen were considered to have normal hearing, I have not been able to be sure that treatment was not received by some of the cases between the examination by Dr. Kerridge, and the hearing test. The records show that of the 144 failures, 20 or 13·9% had been previously noted as suffering from defective hearing. Assuming that the failures in the audiometer test included all children with defective hearing, the percentage of the total number is 1·48. The figure for this same defect in the county generally in 1938 was 0·81%. Again we notice marked discrepancy, i.e. 10·7%, 1·48%, and 0·81%.

The Scope of Routine Medical Examination

Before discussing these discrepancies, however, I would like to say something of the scope and method of routine medical inspections of elementary school children. These examinations take place normally three times in the school life at approximately 5, 8, and 12 years of age, and so far as defective hearing is concerned, the standard required is that the child should hear a " forced whisper " at a distance of 20 ft.

The records required to be kept by the Board of Education of ear defects found at routine examination are under the three headings of " Defective Hearing ", " Otitis Media ", and " Other Ear Diseases ". Each of these is further subdivided by noting whether the defects require treatment, or are to be kept under observation.

In this paper I have not taken account of those children who on account of deafness have been sent to special schools. In the case of any area not having its own school for the deaf, these children do not normally appear in the records of routine school medical inspection except perhaps in the year of ascertainment. Their number is of course small, but includes practically all children who are deaf mutes, or whose hearing is such that, judged by rule of thumb methods, they are unable to make any progress in ordinary schools. There is usually little difficulty in getting parents to allow very deaf children to go to special schools.

Result of Routine Medical Examination

The records of the result of routine medical examinations are of considerable interest, and by the courtesy of the School Medical Officers concerned I reproduce those for 22 of the English Counties in Table IV. The figures are from the Annual Reports on the School Medical Service for 1937. There has been no selection, the areas being equally scattered over the country. None of the areas presents any special features. In Table V I have set out the findings with regard to ear disease in my own county over a period of nine years. During that time six different medical officers have been engaged in the inspections.

TABLE IV.   [YEAR, 1937

PERCENTAGE OF CASES OF

Name of County	Number of routine examinations	DEFECTIVE HEARING			OTITIS MEDIA			OTHER EAR DISEASES			Total of all cases of ear disease
		Requiring treatment	Requiring observation	Total	Requiring treatment	Requiring observation	Total	Requiring treatment	Requiring observation	Total	
Berkshire	6,670	0·34	0·16	0.50	0·22	0·07	0·29	—	0·01	0·01	0·80
Bucks	9,223	0.23	0·05	0·28	0·07	—	0·07	0·42	0·15	0·57	0·92
Cambridgeshire ..	2,607	0·23	0·19	0·42	0·08	0·08	0·16	—	0·08	0·08	0·66
Cheshire	17,631	0·39	0·07	0·46	0·45	0·03	0·48	0·02	—	0·02	0·95
Cornwall	10,486	0·46	0·23	0·69	0·12	0·10	0·22	0·04	—	0·04	0·95
Dorset	4,932	0·18	0·04	0·22	0·04	—	0·04	0·22	0·04	0·26	0·52
Gloucestershire ..	11,395	0·55	0·45	0·99	0·28	0·09	0·37	0·60	1·15	1·75	3·11
Hunts	2,520	—	—	—	0·08	—	0·08	—	—	—	0·08
Isle of Ely.. ..	4,946	0·36	1·13	1·49	0·12	0·28	0·40	0·34	0·22	0·56	2·45
Lancashire ..	36,262	0·19	0·33	0.52	0·33	0·08	0·41	0·69	0·20	0·89	1·82
Leicestershire ..	10,027	0·12	0·01	0·13	0·42	0·06	0·48	0·10	0·05	0·15	0·76
Lincs—Holland ..	2,909	0·17	0·07	0·24	0·21	0·14	0·35	0·28	0·10	0·38	0·97
„ Lindsey ..	11,182	0·11	0·12	0·23	0·16	0·16	0·32	0·35	0·03	0·38	0·93
Norfolk	13,462	0·28	0·45	0·73	0·27	0·18	0·45	0·15	0·31	0·46	1·64
Northumberland ..	13,273	0·53	0·26	0·79	0·94	0·21	1·15	0·02	0·02	0·04	1·98
Nottinghamshire..	15,081	0·15	0·21	0·36	0·64	0·23	0·87	0·48	0·12	0·60	1·83
Oxfordshire ..	4,766	0·15	—	0·15	0·21	—	0·21	0·13	0·31	0·44	0·80
Suffolk—East ..	6,468	0·02	0·19	0·21	0·12	0·70	0·82	0·02	—	0·02	1·05
„ West ..	3,718	0·03	0·11	0·14	0·03	0·13	0·16	—	—	—	0·30
Sussex—East ..	6,580	0·18	0·74	0·92	0·14	0·17	0·31	0·18	0·09	0·27	1·50
Yorks—N. Riding	12,025	0·15	0·01	0·16	0·27	0·06	0·33	0·18	0·08	0·26	0·75
„ W. Riding	46,534	0·35	0·11	0·46	0·65	0·06	0·71	0·21	0·03	0·24	1·41
England and Wales	—	0·30	0·24	0·54	0·39	0·14	0·53	—	—	—	—

TABLE V.

Year	No. of routine examinations	DEFECTIVE HEARING				OTITIS MEDIA				OTHER EAR DISEASE				Total ear disease %
		Requiring treatment		For observation		Requiring treatment		For observation		Requiring treatment		For observation		
		Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	Cases	%	
1930	4,783	2	0·04	8	0·17	—	—	—	—	12	0·25	38	0·79	1·25
1931	3,624	—	—	2	0·06	6	0·17	16	0·44	33	0·91	44	1·21	2·79
1932	3,602	3	0·08	7	0·19	12	0·33	14	0·39	15	0·42	18	0·50	1·91
1933	4,630	10	0·22	15	0·32	10	0·22	13	0·28	20	0·43	29	0·63	2·10
1934	4,138	8	0·19	9	0·22	15	0·36	10	0·24	11	0·27	7	0·17	1·45
1935	3,512	22	0·63	12	0·34	8	0·23	1	0·03	18	0·51	8	0·23	1·97
1936	3,031	22	0·73	19	0·63	5	0·16	11	0·36	10	0·33	6	0·20	2·41
1937	4,946	18	0·36	56	1·13	6	0·12	14	0·28	17	0·34	11	0·22	2·45
1938	3,595	4	0·11	25	0·70	4	0·11	16	0·44	22	0·61	8	0·22	2·19

Assessment of Otitis Media

Dr. Kerridge suggests that deafness was due to this in over half the failures, and possibly in another quarter, the whole being over 7% of all children examined. Though only a small number of these cases had a history of otorrhœa according to our records the special clinical examination indicated otitis media either present or past in only about half the number found by Dr. Kerridge. Even this is, however, much higher than the figure recorded in this or any other county of which I have record. The only explanation is that in fact ordinary routine examination fails to pick up anything other than an obvious otorrhœa present at the time of inspection, and not always that. The number of children found with actual otorrhœa in the present series was about 1·2% of the total seen.

We must of course remember that, while Wisbech is a country town there are in it a large number of people living in conditions comparable to a poor industrial area. There is some reason to believe that otitis media is more common in towns than in rural areas, and the figures for whole counties with large rural areas, as all of them have, are not therefore strictly comparable with those from any particular town, except so far as a comparison between town and country is concerned. Nevertheless and with all reservations it is quite evident that as far as otitis media is concerned our present system fails to find a very large number of those whom regular treatment and care might save from the worst effects of the disease. Within the period of six minutes allotted to the ordinary routine examination, I very much doubt if with the methods now in use a much more exact result may be obtained than at present. If, however, some more rapid method of determining hearing loss could be evolved failures in such a test could be given a more complete examination to ensure that cases of otitis media and other ear diseases were detected. All this, however, proceeds on the assumption that there is a definite degree of hearing loss in every case of otitis media. Otherwise we must assume that of those who pass the audiometer test, a proportion have middle ear disease. Perhaps we shall be safe in assuming that there are few middle-ear cases without some degree of deafness. In any case, granted a careful and leisured examination and with a definition of otitis media which ought to be fairly easy to fix, there would appear to be little difficulty in securing really comparable statistics. The present discrepancies between county and county, and even from time to time in the same county are such as to render the figures completely worthless from a comparative point of view. They are really measures of the extent to which doctors may differ both in opinion and in carefulness.

Assessment of Defective Hearing

Defective hearing, so far as audiometer findings are concerned, was found in about 10% of those examined. Of the failures only one-seventh of the number had a previous history of deafness while the figure for the county was even lower. In other counties

the figures vary from nil to 0·99%, and in the country as a whole was 0·54%. Taking only counties with over 6,000 routine examinations the figure varies from 0·13% to 0·99%, and this discrepancy is greater than one might ascribe to experimental error, nor is it dependent on different social conditions, since adjacent counties having the same general characteristics show rates widely varying. Thus while certain counties on the list which adjoin one another have fairly comparable rates, other counties, which also adjoin and are equally comparable, show rates vastly different. There is in fact no comparison possible, and considered as a means of assessing the actual amount of ear disease in any area, and apart from other information, the figures are in my opinion of very doubtful value.

National Statistics of Ear Diseases in School Children

National figures are published in the Annual Report of the Chief Medical Officer of the Board of Education for 1937 (Health of the School Child) and are as follows :—

Defective hearing requiring treatment 0·30%, requiring observation 0·24%, and otitis media requiring treatment 0·39%, requiring observation 0·14%. In the same report is also published the incidence, for the previous five years, of these defects requiring treatment as follows :—

	1933	1934	1935	1936	1937
Defective hearing ..	3·3	3·2	2·8	2·9	3·0
Otitis media	4·6	4·6	4·1	4·0	3·9

(Figures are *per thousand* routine examinations)

These figures in comparison with the individual results from separate areas illustrate that an average involving a very large number of children and a very large number of doctors does not of itself give any indication of how the findings may vary as between doctor and doctor or between different areas. What then do the figures tell us ? Do they really indicate the prevalence or otherwise of ear disease in the country or differences from year to year in the incidence of such disease ? Bearing in mind the large internal variation of their component figures, I do not really think that they tell us anything of the sort.

It is not only as regards ear disease that this disparity of findings is noted. In the course of an enquiry into nutrition, I made a somewhat similar extract from the reports of School Medical Officers of the assessment of nutrition in school children. I also made a comparison of the findings of four doctors in my own county. The difference between doctor and doctor and county and county were equally marked. The most careful investigation of this sort of which I know is one by Mr. Huws Jones published in the *Journal of the Statistical Society* upon this very question of the assessment of nutrition. He shows very clearly that such assessments not only vary from doctor to doctor, but also from time to time in the case of the same doctor.

The Reliability of Hearing Tests

The standards at present used in routine examinations are, as far as exactness and comparability are concerned, quite valueless. The Board of Education Committee's Report on children with defective hearing deals with these various tests, and defines the " forced whisper " as being spoken with " the chest fixed at full expiration" and the examiner 20 ft. away from the child. I have not the slightest hesitation in saying that apart from its inherent defects, I am quite sure that it is impossible and impracticable in the majority of cases to carry out the test in the manner stated. Size of room, presence of parents and children, and extraneous noise all militate against it. The report mentioned says that advocates of the " forced whisper " test say it is more " standardized and less subject to variations in audibility " than the " spoken voice " test and that overtones are almost absent.

However, the report condemns the test as it does also the watch test. In the case of the latter it is said that its results have little relation to the loss of hearing for speech owing to the fact that the tick of most watches consists of vibrations of higher frequencies than the " speech frequencies ". (Yet one hates to lose the attributes of convenience and portability which the watch represents, and which would otherwise make it so useful in the routine examination of school children.) I ought here to mention the " spoken voice " test. The Board of Education Committee's Report admits that the audibility of different persons voices varies within wide limits, and is less standardized than even the " forced whisper ". It nevertheless recommends its use in determining whether a child requires special educational provision, but only secondary to mass testing by the gramophone audiometer.

The Gramophone Audiometer

The Board of Education Report has also gathered together most of the details regarding audiometer tests and has set out the findings of a number of investigations carried out by means of it. The report concludes that the incidence of partial deafness requiring special teaching in special classes or schools, but not including children suitable for ordinary deaf schools, is about 0·5 per thousand in the country generally ; that a figure varying from 0·5 to 2 per thousand may represent the number requiring special treatment (i.e. hearing aids, favourable positions in class, &c.) in ordinary classes in ordinary schools and that a further 50 to 80 per thousand deaf children require no special educational arrangements of any kind though they may require medical attention. The Report advocates routine audiometer testing of school children on the ground that it picks up twice as many children requiring special educational help than are detected by ordinary routine methods, and that in any case most of the large numbers of failures require medical attention.

There is in the Annual Report of the School Medical Officer for Lancashire for the year 1937 an interesting account of an audiometer test carried out by Dr. R. W. Eldridge in certain schools in that county. The number of children found to have " a considerable degree of hearing loss " (i.e. 18–30 units of hearing loss in both ears) was 52% of the children tested, and this curiously enough is also the percentage of children in Lancashire found during 1937 to have defective hearing at routine examination.

The percentage of children noted in both reports as requiring special educational help is very small indeed, and one is tempted to ask whether in fact, with a more careful application of present methods, or preferably by the use of some simple standard hearing test, most of these children could not be picked up at routine examination, as might most of the other failures, either on grounds of defective hearing or because of actual abnormality of the ear.

To summarize the advantages of the audiometer test, one puts first the claim that it picks out twice as many deaf children requiring special aid than ordinary clinical methods, and secondly that it gives a standard test and not one peculiar and personal to each examiner.

I have suggested that these two advantages can be equally secured, the first by a more careful routine examination and the second by some simple variant of the watch test. From a practical point of view routine audiometer testing has some definite disadvantages. For instance administratively it is bound to cause a certain amount of disorganization of school routine additional to that already caused by routine medical inspection, besides involving expense in time and staff which may be slight in a wealthy borough, but which may be comparatively much heavier in a poor county.

Another objection is that the audiometer test is only claimed to be really reliable in children of 8 years and upwards and therefore those below that age must in any case be dependent upon the ordinary examination.

This difficulty in testing young children is to some extent a question of general intellectual and psychological development, and I feel that in the Board of Education Report this has not been given sufficient weight. For instance the giving of the gramophone audiometer test presupposes the continued attention of the child, which is by no means always easy to secure or maintain, while in mentally deficient and dull and backward children it is necessary to decide whether the child is unable to hear because he has ear disease or simply because he is dull; and in some cases both factors will be present.

I think we must not lose sight of these disadvantages of the audiometer while remembering that it is certainly a means of discovering far more ear disease than is normally found at school medical inspection. Yet I think that it pitches too high a standard as used at present, and it is a great disadvantage that the test is not one which can be rapidly applied at a routine examination. I should like to see introduced some standard source of sound made in such a way that the amount heard could be accurately measured in a minute or so, such as a standard watch mounted on a graduated slide with perhaps a headpiece to fix the position of the ear relative to the watch.

Summary

(1) The usual statistical returns of ear disease in school children are so variable that they cannot be regarded as indicating the prevalence of ear disease with anything approaching accuracy.

(2) All *ad hoc* investigations, whether by means of the audiometer or otherwise, make it clear that much " middle ear " disease is missed in the course of the routine examination of school children.

(3) While there is a great need for a uniform method of examining hearing, something simpler than the audiometer is required so that the necessary test may be carried out at routine examinations.

(4) Whatever the test it is virtually impossible to eliminate psychological factors in the child as a possible source of error.

In conclusion I should like to thank Dr. Kerridge for permission to refer to her audiometer tests in Wisbech, and for her advice in writing this paper, and to Dr. Joscelyne and Dr. Crawley for the care with which they carried out the clinical examinations.

REFERENCES

Board of Education Report of the Committee of Inquiry into Problems relating to Children with Defective Hearing, 1938.
Annual Report of the Chief Medical Officer to the Board of Education, 1937.
Annual Report of the School Medical Officer for Lancashire, 1937. (Special Report on Defective Hearing in School Children as measured by the gramophone audiometer.)
Physical Indices and Clinical Assessments of the Nutrition of School Children, R. Huws Jones, M.A., B.Sc.(Econ.), *J. Roy. Statistical Soc.*, **101**, Part 1, 1938.

The President said that the three openers had given very interesting and useful papers. There were two subjects to discuss, the prevention of deafness, which was of national importance, and the treatment of children already deaf, together with the prevention of the increase of deafness.

Dr. Wells had mentioned some methods of treatment, in particular, diastolization. It was important to know whether the parents could carry out treatment by diastolization after they had been instructed.

Dr. C. Eisinger said ear diseases in children could not be really explained except by reference to the anatomical facts and the specific reactions. Take, for example, the temporal bone. It would be found that the middle ear from birth was in a constant condition of regressive movement, whereas the mastoid

process from birth was in a condition of progressive development. An organ which was in constant histological and physiological movement must react on disease process in a different way from a " silent " organ, and thereby some special features in the course of acute otitis in children might be produced and the cause of certain complications explained.

He had devoted at least six or eight years to the X-ray examinations of such cases, and still he found some difficulties which could not be overcome. These were explained again by reference to the anatomy. The mastoid process and even the process of normal pneumatization were not exactly known by X-rays, and when to these unknown conditions of the normal mastoid were added the pathological conditions of an otitis or mastoiditis it would be understood why so little was known about the X-ray appearance of the mastoid. Yet none could say that the X-ray examination of the mastoid was not necessary.

With regard to the special types of otitis which were only found in children, he would mention otitis media simplex. This began with a high temperature and pain, and in the ear a discrepancy was found between the drum picture and the temperature. The high temperature could not be explained. Though the pediatrician did not find anything in this type of disease yet the otologist and the pediatrician were mutually dependent.

Another type of otitis, only observed in children, was otitis media fibrinosa. In this condition there was no discharge except a little pus or serous fluid ; there was some degree of temperature and some pain, and there was a thick fibrinous clot. On this clot being removed the picture on the following day might be unaltered, and it was not until after five or seven days that secretion began. This could only be explained by the special structure of the middle ear, not by the action of bacteria.

Another interesting fact was that nearly always otitis was bilateral in children, but very seldom so in adults. As to the end-results of otitis, each of them must have operated on many cases of acute otitis in what was thought to be the best and most exact way, and yet they had been unable to prevent the formation of retro-auricular fistula. The vast majority of such cases were in children.

Scar abscesses were also more common in children. On the other hand, in children mastoiditis was more benign.

As for complications, endocrine and autogenic complications in children offered special difficulties. Cerebellar abscesses were extremely rare, meningitis was more common, and very often there was a special type of sinus infection. Nearly always there was found in children the so-called primary jugular thrombosis. It began with a high septic temperature and the trouble was very often bilateral. This was one of the difficulties not yet overcome in children.

An interesting fact was that lumbar puncture in young children in the first years was not reliable, because the so-called blood-cerebrospinal fluid barrier was not yet working. On the reaction of the infantile pain he called attention to an interesting paper in the most recent *Journal of Laryngology and Otology* on acute hydrocephalus,[1] a condition very often found in children and difficult to distinguish from meningitis.

As to the prognosis of meningitis, the respective numbers of cured meningitis cases in children and in adults were very striking. The figures he had in his mind were about 22 cases of healed meningitis in children to one healed case in an adult. He had attempted a comparison of these figures as between the pre-sulphanilamide era and the present, but the vast majority of cases of healed meningitis after sulphanilamide were also children. It might be that the infantile brain reacted earlier, that the damage was more frankly discernible, and that attention was more quickly drawn to complications in children.

[1] Asherson, N. (1939), *J. Laryng.*, **54**, 319.

To-day special attention was being drawn to the prevention of complications following standard treatment and the prevention of the consequences of otitis. The number of radical operations necessary in the case of poor people in hospital was much greater than in people with more comfortable means. The reason as stated by a recent authority was that chronic otitis was the consequence of impeded pneumatization of the mastoid, the result of early catarrh of the ear, nose, and pharynx. Among the poor there was a much greater incidence of impeded pneumatization, and they were inclined much more to have chronic discharges, so that many more cases of hardness of hearing were found among the people of that class.

Mr. T. Ritchie Rodger said that in tackling this subject of the prevention of deafness of children of school age he thought they were really getting down to bed rock in their crusade against chronic ear trouble. Dr. Wells had said that in the London figures the chronic ear case was still very much in excess of the acute ear in school examinations. Unless these children could be got hold of in the acute stage not very much headway would be made. He did not know what arrangements were made in London towards getting over this difficulty, but for some years now in Hull, an arrangement had existed whereby children of pre-school age were sent to the school aural clinics from the child welfare centres. He had been doing this work for a dozen years now, and during half that time they had been getting cases from the child welfare centres and now, among about thirty children at a session there would be half a dozen infants or very young children from the child welfare centres. Those centres, were, of course, worked by the same people and were under the same authority. By that means they got hold of a large number of acute as well as chronic ear cases. Only yesterday after an aural clinic the elderly nurse who had been in the service very much longer than he had himself, remarked to him spontaneously on the small number of chronic ear cases now forthcoming, as compared with the old days.

Mr. Terence Cawthorne said that in London during the last eight or ten years there had been a very marked diminution in the number of cases of chronic suppurative otitis media which required attention. He thought that this could be attributed directly to the special ear clinics, the establishment of which was largely due to the untiring efforts of Dr. Wells.

Mr. W. S. Thacker Neville asked how long the sitting for diastolization continued and how many times it was repeated. Did Dr. Wells' use of diastolization include local treatment of the ear with boracic and iodine ? Did he not wash out the sinuses ? Why did he use the chlorine ionization over the mastoid area when he could more easily introduce it into the middle ear by way of the meatus ? Did he believe that the chlorine did enter the middle ear from the mastoid ?

He asked whether Dr. Lonie did not instruct school teachers in the use of the gramophone audiometer. With regard to the watch, if a person using a gramophone audiometer had a 12% loss of hearing, he would only hear a watch at a few inches. He knew that the watch was the wrong thing to use and that the frequencies were too high, but still it was so convenient that he hoped it might remain in use.

With regard to Dr. Eisinger's remarks on recurrence of mastoid trouble in children, was this not due to the re-formation of bone ? He did not believe that primary bulbar thrombosis was common in England, and so he did not think that Dr. Eisinger's statement on this point applied to England at all.

Mr. I. Tumarkin said that they must all welcome Dr. Kerridge's statistics which showed that chronic otorrhœa was far more common in children than was supposed. But it seemed to him a pity that they should concentrate so largely on the question of statistics and ignore the practical point of how to improve the figures.

He recalled that at a discussion of the Society of Medical Officers of Health one member mentioned that in his hospital cases of otorrhœa were kept in for two or four or even six months because their ears were discharging. He did not seem to think that it was necessary to call an otologist in. When he himself was appointed to a quite small local fever hospital he found children whose ears had been running for two or three months. Some quite simple treatment was arranged and within a week about twenty cases had healed up. If the cases in fever hospitals could be brought under simple treatment the incidence of chronic otorrhœa would be greatly reduced.

He did not agree that the watch test was so very far removed from the range of useful frequencies. The watch tick had a frequency round about 2,000. That was quite a useful range. In his view the gramophone audiometer did not give much more information. The gramophone audiometer was based on the spoken voice repeating numbers, and it would be noticed that all these numbers, one, two, three, and so on, contained a vowel. Any intelligent child could recognize a number from the vowel. The vowel had two bands of frequencies, the lower one about 600, and the upper perhaps 3,000 to 5,000. No gramophone audiometer at present constructed would give the upper frequency of the vowel. The children recognized the vowel from a tone of round about 600, and therefore he did not think the gramophone audiometer was very greatly superior to the watch from its frequency range. Moreover, the gramophone audiometer had to be carefully watched. There was commonly attached to it a series of telephones, and if one of these telephones was out of order the child using that phone would be wrongly assessed. There was also a liability to error with the gramophone audiometer if one was careless in placing the needle. Despite these limitations, the gramophone audiometer was a valuable instrument for its own special purpose—namely the rapid-rough testing of a large number of children by an examiner who did not need to have any special qualifications.

Finally, he spoke of the usefulness of the notification of otitis media. With such notification the medical officer of health would have a list of all cases at their onset, and this would help him to decide whether a case was cured or not.

Mr. A. G. Wells (in reply) said that it was very encouraging to learn that there were areas in the country where chronic suppurative otitis media was almost non-existent and where only acute cases could be found. As far as London was concerned, he had mentioned in the paper a Ministry of Health Circular 1337a, which recommended local authorities without aural services to take advantage of the service of another authority that had such a service. This had had a poor response in London. Areas which might have been expected to take advantage of it had not done so, and the result was that the children with acute ears were not dealt with to the extent they ought to be. Another point to be remembered was that London was an enormous area and it had been necessary for them to feel their way. They could not start with an adequate number of otologists to deal with the whole child population, but by degrees a service had been built up which he thought was now sufficient to cover the cases as they occurred. There were fourteen ear, nose and throat surgeons on the London County Council staff, and through the work they had done it had been possible to arrive at the point where there was no long waiting list such as they had always had in the past. As the children came, so they were dealt with. Places around London, such as Tottenham and Hornsey, had the same experience as Mr. Ritchie Rodger had mentioned in his district. The chronic cases had been practically

eliminated because the pre-school child had been brought to the clinics, and there was sufficient assistance to deal with the school population.

In reply to Mr. Thacker Neville's questions he thought the first point raised was the question as to how long this diastolization went on. What he recommended was that the smallest size of bougie should be introduced into the nose and left for about one or two minutes before the to and fro movements were initiated. Then, after about forty such movements, it might remain for another minute and the other side could then be done. Then the bougies could be taken out, the next size inserted, and the process repeated. No hard and fast lines could be laid down for this treatment. Sometimes it was necessary to carry out fewer than forty movements to and fro, and sometimes no movements at all could be done. All these things depended on the case.

As to how often the treatment was repeated, it was carried out twice or three times a week in some cases. The cases were not kept on for years and years. The child was seen by the otologist, and if he thought that the condition had been sufficiently benefited by the original course of twelve sessions he discontinued treatment. If he thought a further course advisable another twelve treatments were given. It depended entirely on the progress made.

With regard to the boracic and iodine treatment, as a matter of fact this had been used for many years and good results obtained but, of course, no treatment would be really effective unless the case was uncomplicated or, if complicated, the complicating conditions were such as could be easily dealt with. But while Mr. Thacker Neville's treatment with boracic and iodine would be likely to go on for some weeks, even if he did it himself, the same result would be achieved by ten minutes' ionization treatment.

With regard to chlorine ionization he did not see why the introduction of the ion should be through the meatus rather than on the mastoid process. He had never thought of doing it through the meatus and did not see why it should be done.

The Position of the Portmann Operation in Relation to Labyrinthine Vertigo

By E. Musgrave Woodman, M.S.

In a paper on the operative treatment of labyrinthine vertigo, it must always be borne in mind that the majority of cases can be cured by conservative treatment only, and a proper prospective must be retained.

The condition appears to be one of labyrinthine hypertension, and a unilateral deafness is often present in the affected ear. On testing, a condition of hypotonus is usually present.

It is always important to exclude high blood-pressure and investigations into this must be undertaken at the outset.

In Denmark a great deal of importance is attached to the presence of water retention and defective excretion, and many cases are demonstrated in Copenhagen in which vertigo apparently owed its origin to this cause. Treatment is directed to relieve this condition.

Sir James Dundas Grant some time ago called attention to the importance of the Eustachian tube in relation to vertigo. Complete blockage of this tube leads to vascularity of the middle ear and increased secretion of fluid in the perilymph and endolymph.

It is certain that if a blocked Eustachian tube is treated along the lines of a urethral stricture, and a bougie is passed at increasing intervals, complete cure results in the great majority of cases. Should the tube be completely impermeable complete cessation of the symptoms will result from a section of the membrana tympani, and a case illustrating this was given.

Only a few intractable cases require major operative treatment, and this paper is restricted to the results obtained by the Portmann operation.

A careful radiogram is taken in the first place and the condition of the bone ascertained. If compact, and the lateral sinus is shown to be well forward, the operation may be very difficult. If cellular development is well marked, the operation is easy and the general result satisfactory.

The mastoid process is opened up and the bone removed down to the dura of the posterior fossa, between the lateral sinus behind and the mastoid in front. The dura is then carefully lifted up from the postero-superior surface of the petrous bone. The point at which the ductus vestibuli reaches the surface is carefully noted and it is marked by a small adhesion. This is forcibly elevated and in favourable cases a small drop of clear fluid is seen to come out.

If the aqueduct is not located the operation proceeds until the internal auditory meatus is reached, by which time it is clear that the duct must have been passed, although of course it may have been absent. The parts are then allowed to fall together and the wound is sutured without drainage.

The difficulties are extreme density of the bone, the forward position of the lateral sinus and hæmorrhage of the emissary veins. In two cases the operation has had to be abandoned temporarily, but was completed satisfactorily the following week. Congenital variations in the duct must be expected. I think the difficulty most likely to be present is that the bone is very dense. It cannot therefore be possible that every operation will be successful.

The contra-indication is sepsis in the middle-ear cleft, and it is absolute.

Results

I have eleven cases recorded in my Clinic, on which I have operated on eight and my colleague, Mr. Stirk Adams, on three—there have been no fatalities or accident.

Vertigo.—Eight have been completely cured of vertigo, one was much better, one cannot be traced and one failed. Probably in the latter case there was atresia of the duct, as no effect was produced on the giddiness, tinnitus, or hearing.

Tinnitus.—Two cases were completely cured, one greatly improved, eight remained the same. This shows that there is a tendency to improve the tinnitus, but it cannot be relied upon.

Hearing.—One case was practically restored to normal, five were improved, one case was made worse and four were unaffected. Audiograms were shown of two cases before and after operation.

I have not carried out the operation on the semicircular canal because I have been satisfied with the Portmann operation, which has two distinct advantages. It is free from danger and from risk and is easy to perform successfully, and there is a prospect of improving the hearing. In any operation on the canal the hearing is damaged or even destroyed.

Summary

There are only a few cases in my experience which require operative treatment, and these are successfully dealt with by the Portmann operation. The results for vertigo are very satisfactory and are shown to be permanent. The effect on the hearing is less reliable, but in no case was the hearing destroyed.

MR. MUSGRAVE WOODMAN : PORTMANN'S OPERATIONS.

No.	Condition before operation	Condition after operation			Remarks
		Tinnitus	Hearing	Vertigo	
(1)	Severe attacks of vertigo with loss of consciousness, 1930	—	Rather worse	Completely cured	—
(2)	Severe vertigo, deafness, 1930	—	Improved	Completely cured	—
(3)	Severe vertigo, tinnitus, deafness, 1931	Completely cured	Improved	Completely cured	—
(4)	Severe vertigo, deafness, 1929	—	Great improvement	Completely cured	—
(5)	Severe vertigo, deafness, 1931	—	Improved	Completely cured	Severe hæmorrhage. Two-stage operation
(6)	Deafness, tinnitus, 1932	Completely cured	No improvement	—	(Not traced)
(7)	Severe vertigo, deafness	—	As before	Completely cured	Audiograms
(8)	Severe vertigo, deafness, W.S.A., 1937	Great improvement	Improved	Completely cured	Audiograms
(9)	Vertigo, tinnitus, deafness, 1938	As before	As before	Vertigo much improved	Functional element strong
(10)	Severe vertigo, deafness, W.S.A., 1938	—	As before	Completely cured	—
(11)	Severe vertigo, deafness, tinnitus, 1937	No improvement	As before	No improvement	Died 1938, cerebral thrombosis

Mr. Stirk Adams said his own technique had followed closely that described by Portmann in the *Journal of Laryngology and Otology* (1927, **42**, 809). He had been greatly interested in the possibility of conservation or improvement of hearing after the operation. Some years ago his colleague, Naylor Strong, had shown him a patient where six months after the Portmann operation had been carried out on the worse hearing ear for vertigo the hearing had improved to a distance of 15 ft. for the whisper on the operated side, while on the previously better side the whisper was only heard at 15 in. In addition the man had been completely free from attacks of vertigo from the date of operation and had been able to resume his normal duties. From this result, and from one of his own which was included in the paper, he had come to the conclusion that apart from its other advantages the Portmann operation might produce a very great improvement in the hearing. He felt the advantages of the Portmann operation, where operation was required for incapacitating attacks of aural vertigo, merited the closest consideration, as many of these patients had a useful degree of hearing in the worse ear. In these cases he thought we were not justified in sacrificing the hearing by labyrinth destruction if the same result could be obtained by the Portmann operation without loss of existing hearing capacity.

For the aural vertigo requiring operation we had available : Section, or hemi-section of the 8th nerve ; destruction of the labyrinth by alcohol injection ; or partial destruction by diathermy through the superior semicircular canal, and the Portmann operation.

Section of the 8th nerve could give a completely successful result, but in the hands of neurosurgeons in this country the risks of the operation had been proved to be much greater than the risks associated with the labyrinth operations or with the Portmann operation. For this reason he thought that section of the 8th nerve in the posterior fossa had fallen into disuse, while alcohol injection of the labyrinth entailed a complete destruction of the hearing. Partial destruction of the labyrinth

by surgical diathermy in conservation of the hearing was still in the experimental phase. In the two cases described by Putnam (*Arch. Oto-Laryngol.*, **27**, No. 2, 163), however, a secondary operation had been required.

It appeared to him clear from what had been said previously that the Portmann operation offered tremendous advantages, and the fact that in two cases great improvement in the hearing had resulted in addition to cure of vertigo justified a much wider use of the operation than existed to-day.

In the medical treatment of vertigo his own experience entirely corroborated Mr. Woodman's, that restriction of water intake played little part in the control of the attacks. In these circumstances he felt it was a great penance to ask the patient to restrict his water intake so severely as so little benefit was likely to be obtained. He would, however, like to draw the attention of the Members of the Section to the diet used by James Adam to control aural vertigo. This consisted of :—

> 4 oz. of raw green vegetables (sprouts, cabbage, lettuce, celery, &c.).
> 1 lb. of fruit (apples, bananas, &c.).
> 2 pints of milk.
> Wholemeal bread, with very little meat but any other kinds of vegetable.
> One glass of hot water night and morning.

Dr. MacArthur of Stourport first drew his attention to this diet which had abolished attacks of aural vertigo in a patient who had been under his care for the past six years. This patient, aged 50, began to suffer from aural vertigo six years ago and at that time he had a closed Eustachian tube with a severe degree of deafness on that side. Treatment by bougies proved the tube impassable, and a Nesfield operation had been carried out, opening the mastoid antrum to the external auditory canal. This opening had remained patent, but in spite of this, attacks of vertigo had persisted and hearing had slowly deteriorated in the interval. Three months ago the patient was getting three severe attacks of aural vertigo every week, and after starting the diet mentioned above the severe attacks of vertigo completely disappeared although a transient unsteadiness is present at times.

Mr. Herbert Tilley referred to the case of a general practitioner, aged **62**, who had been confined to his bed for about ten days by severe attacks of vertigo, vomiting, persistent deafness and tinnitus in the left ear. The ordinary hearing tests proved the deafness to be of the " middle-ear " type, and the responsible lesion was found to be obstruction of the Eustachian tube. Immediately after this factor was removed by means of a Politzer bag, normal hearing returned, the patient experienced no sensation of giddiness and resumed his work on the following day. There was no recurrence of the typical Ménière's syndrome from which he had suffered. It would seem obvious that the order of events was : catarrhal closure of the Eustachian tube, exhaustion of air in the " drum " with coincidently increased atmospheric pressure on the tympanic membrane which was conveyed by the ossicles and via the " fenestra oralis " to the endolymph of the corresponding labyrinth.

Some of us will, doubtless, recollect that in the Great War, many of our air pilots and/or their observers were subject to " giddiness " during, or immediately after a rapid descent. As a general rule, auto-insufflation of the middle-ear clefts sufficed to restore normal equilibrium. In Mr. Sydney Scott's personal experiences, this method rarely failed to give relief. It has often occurred to me that many of the, almost daily, " crashes " may be due to a sudden attack of vertigo initiated by some catarrhal factor in the nasal or nasopharyngeal cavities. We know it to be true in patients who have never travelled by " air " and therefore it is particularly important that such conditions be eliminated before accepting candidates for the passenger, Army, or Navy Services.

On the Histological Changes in the Temporal Bones of a Case of Ménière's Disease

By C. S. Hallpike, F.R.C.S.

(*From the Ferens Institute of Otology, Middlesex Hospital, London*),

and

A. J. Wright, F.R.C.S.

(*Bristol*)

In a previous communication [1] a description has been given of the pathological findings in the temporal bones of two typical subjects of Ménière's syndrome. Certain peculiar changes were disclosed in the labyrinth and the findings were considered, for this reason, to support the view that the disorder was due to a disease *sui generis* of the labyrinth itself. The temporal bones of a third case have now been examined, and it is the purpose of the present paper to record the results.

The clinical details were as follows :—The patient was a man aged 29, and a clerk by occupation. The previous history obtained from the records of his family doctor and dating back to 1925 showed that he had been a healthy man, the only illnesses of any importance being two attacks of " acute pharyngitis " and three of " influenza ". The present illness started on January 8, 1938, with some defect in the hearing, a " rushing " tinnitus and a sensation of fullness all in the left ear. These symptoms were present intermittently until April 30, 1938, when the first attack of vertigo occurred. This attack was sudden in onset and severe in degree, lasting for some hours and accompanied by a sensation of being forced round to the left and followed by severe vomiting. Similar attacks of varying degrees of severity occurred at intervals of two or three weeks until he was admitted to hospital on September 16, 1938, i.e. about eight months from the onset of the complaint.

Other points of possible importance in the history, obtained on admission to hospital, were the complaint of a tendency to stiffness and " creakiness " of the joints for some months, and in addition to the sensation of fullness in the left ear already mentioned, he stated that he had an intermittent left-sided temporal headache. There was also a complaint of nasal obstruction and thick discharge of some years' standing, with a liability to attacks of sneezing and running from the nose.

On examination, the tympanic membranes were normal, and hearing distance for the conversational voice was apparently normal on the right side but on the left was reduced to 6 ft. Bone conduction for a tuning fork was diminished on the left side and the audiogram showed a considerable high tone loss on the left side with normal hearing on the right. The tonsils were enlarged and grossly infected, and clinical and X-ray examination showed a bilateral antral sinusitis.

Audiogram (Fig. 1)

On September 19, 1938, the tonsils were removed and an intranasal opening made into the antrum below the inferior turbinal on either side, and in addition, a limited submucous resection of the septum was performed to facilitate antral drainage. He left the hospital five days later but was readmitted with a secondary hæmorrhage from the left side of the nose, nine days after the operation. He eventually died on October 29, 1938, five weeks after the operation, as a result of repeated secondary hæmorrhages.

As to his terminal illness, the first hæmorrhage took place nine days after the operation and recurred on eight further occasions. He was transfused five days

before death. In addition, he had the nose plugged on many occasions, and, as a result, some bilateral infective changes in the middle ear took place. As evidence of this, on October 15, 1938, i.e. two weeks before death, the tympanic membranes were injected and there was probably some fluid in the middle ears. No ear discharge or pain were subsequently noted, but the serious nature of his condition and the repeated hæmorrhages prevented any particular attention being devoted to the condition of the ears during this final period. He actually died in the operating theatre as a result of a terminal severe hæmorrhage, with a small amount of chloroform and ether as an additional factor. At the post-mortem examination performed twenty hours after death, the site of hæmorrhage was found to be a sloughing area in the left maxillary antral floor in the region of the opening made at operation.
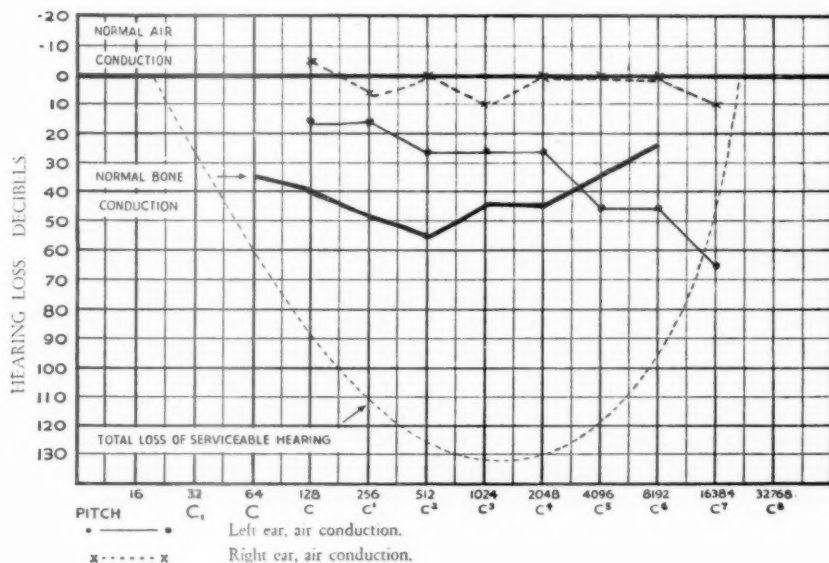
FIG. 1.

There was a delay of twenty hours in removing the temporal bones after death and they were eventually delivered to the Ferens Institute on November 4, 1938, nine days after death.

The actual specimen had been skilfully removed and consisted of the base of the skull with the temporal bones, 8th nerves and a portion of the medulla in undisturbed relationship. The temporal bones were detached and prepared together for histological examination under identical conditions. Embedding was in celloidin, and serial sections were cut in the horizontal plane at a thickness of $25\,\mu$.

The 7th and 8th nerves were divided at their points of entry into the internal auditory meatus and again at their attachment to the brain-stem. The intervening lengths of the nerves were embedded separately in celloidin and sectioned at $25\,\mu$ in a transverse plane.

HISTOLOGICAL FINDINGS
Right Temporal Bone

Pneumatization.—The apical portion of the bone contains a number of large red and fatty marrow spaces. Air spaces are absent.

Around the antrum the air cell system is fairly well developed. The cells are of moderate size, contain pus and are everywhere lined by thick organizing granulation tissue, infiltrated with polymorphonuclear leucocytes.

Labyrinth capsule.—This shows no abnormality. The fissula *ante fenestram* is present and well developed. There is also a well-marked fissula *post fenestram*.

External auditory meatus.—Normal.

Tympanum.—The posterior part of the tympanic cavity is filled with pus. The tympanic membrane is intact but grossly thickened by a layer of dense granulation

FIG. 2.—Right temporal bone. Low-power view showing inflammatory changes in the tympanum.

tissue on its deep aspect. The ossicles are surrounded by granulation tissue but no changes are visible of their bony structure or in their marrow spaces.

A low-power view of the state of development of the pneumatic and marrow spaces and of the inflammatory changes within the tympanum is shown in fig. 2.

Vestibule.—No abnormality is present in the size or disposition of the endolymph spaces. The maculæ of the saccule and utricle show conspicuous post-mortem degeneration but are otherwise normal.

Semicircular canals.—There is well-marked sub-epithelial vesiculation within the membranous canals of the type previously described [1]. It is particularly marked in the anterior vertical and lateral canals and is probably not in excess of normal limits.

The sensory epithelium shows no abnormality apart from a marked degree of post-mortem degeneration.

The cochlea.—This appears normal as regards both the disposition of Reissner's membrane and the density of the spiral ganglion (fig. 3).

The organ of Corti.—This is normal apart from well-marked post-mortem degeneration (fig. 4).

The stria vascularis.—Post-mortem degeneration is severe, but no other structural abnormalities can be recognized.

Fig. 3.—Right temporal bone.   The cochlea.   No abnormality is present.
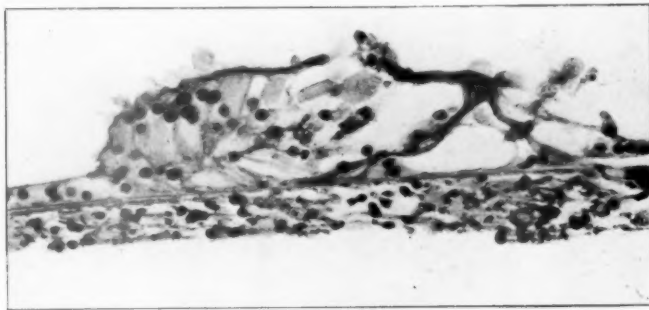
Fig. 4.—Right temporal bone.   The organ of Corti showing post-mortem degeneration only.

The aqueduct of the cochlea.—This is normal and patent throughout its length.

The saccus endolymphaticus.—The lumen shows an unusual degree of collapse with close apposition of the lining epithelium. Here and there spaces are present which contain a red-staining colloid material.

In a previous communication [1] reference was made at some length to the work of Guild upon the normal anatomy of the saccus endolymphaticus.

According to Guild [2] the endolymph is absorbed through the lining epithelium of the saccus into a certain loose-meshed perisaccular connective tissue. The normal condition of the human saccus and perisaccular connective tissue is shown in fig. 5.
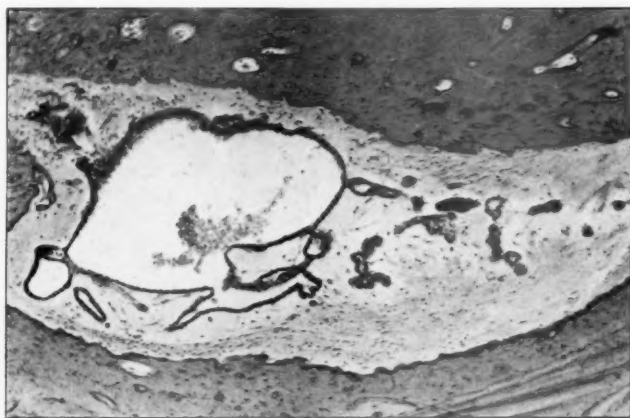
FIG. 5.—A human saccus endolymphaticus showing the "normal" area of loose meshed connective tissue surrounding the saccus.
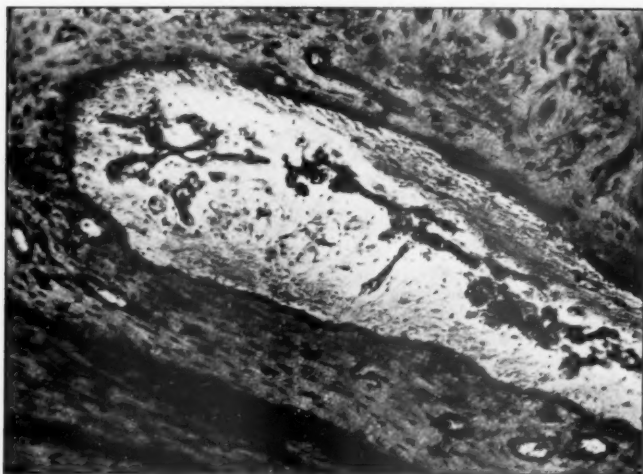
FIG. 6.—Right temporal bone. The saccus endolymphaticus showing a "normal" state of development of the perisaccular connective tissue.

Fig. 6 shows the condition of the right saccus in the present case, with a moderate development of the perisaccular connective tissue.

Internal auditory meatus and 8th nerve.—The 8th nerve has been divided through

its glial portion and shows no structural abnormalities. Scarpa's ganglion is normal in density and cell structure.

A few scattered red cells and small lymphocytes are present in the deeper parts of the meatus.

Examination of the 7th and 8th nerves between the internal auditory meatus and the brain-stem showed no abnormalities.

Left Temporal Bone

Pneumatization.—The apex is acellular with a number of large marrow spaces containing red and fatty marrow. Around the antrum the air spaces are numerous and of moderate size. They are filled with pus and lined by dense organizing granulation tissue thickly infiltrated with polymorphonuclear leucocytes.
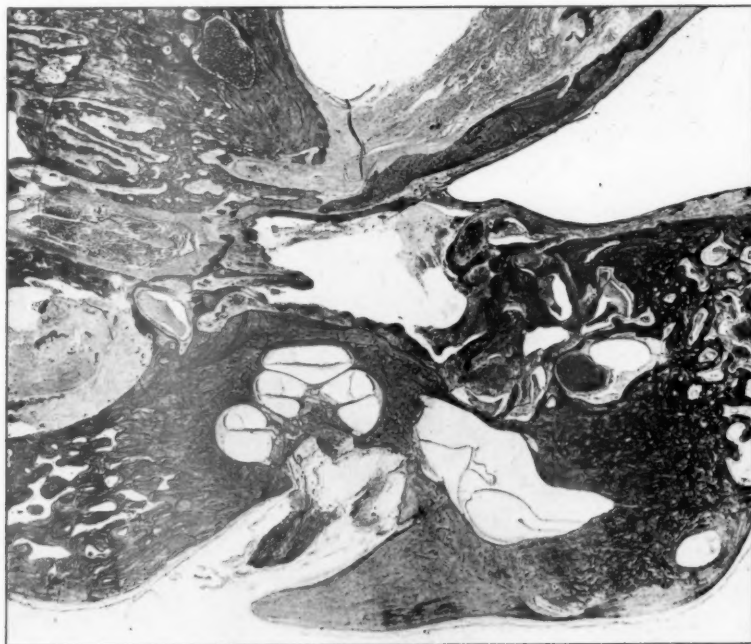
FIG. 7.—Left temporal bone. Low-power view, showing inflammatory changes in the tympanum.

External auditory meatus.—Normal.

Labyrinth capsule.—This shows no abnormality. The fissula *ante fenestram* is present and well developed. There is also a well-developed fissula *post fenestram*.

Tympanum.—The tympanic membrane is intact but lined by dense granulation tissue. The posterior part of the tympanic cavity is filled for the most part with pus and granulation tissue. The ossicles are enveloped in this tissue but show no changes of their bony structure or within their marrow spaces.

A low-power view of the state of development of the pneumatic and marrow spaces and of the inflammatory changes within the tympanum is shown in fig. 7.

Vestibule.—The endolymph spaces are normal in size and disposition, and the maculæ of the saccule and utricle appear normal apart from considerable post-mortem degeneration.

Semicircular canals.—There is a marked degree of sub-epithelial vesiculation within the membranous canals. As in the right labyrinth its pathological significance is doubtful. The epithelium and innervation of the cristæ appear normal apart from severe post-mortem degeneration.

The cochlea.—There is considerable distension of the scala media. It is present in all parts of the cochlea, but is particularly well marked in the posterior basal and anterior middle whorls where Reissner's membrane has been thrown back into contact with the wall of the scala vestibuli over approximately one-third of its length.
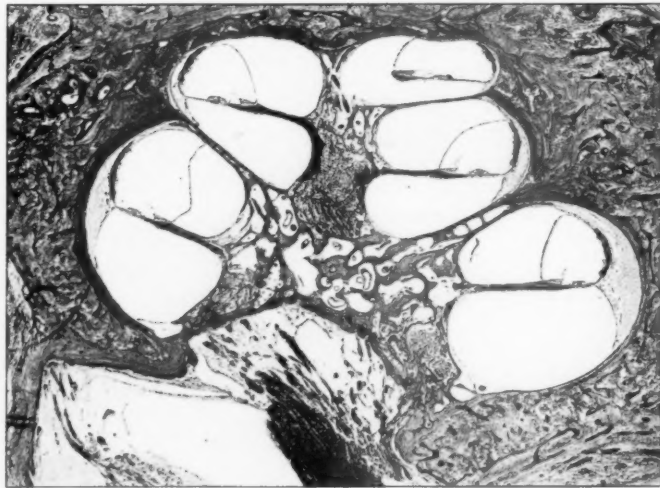
FIG. 8.—Left temporal bone. The cochlea, showing the distension of the scala media with the formation of folds in Reissner's membrane.

In addition, the presence of a number of folds in the free portion of the membrane provides striking evidence of a considerably greater distension of the scala media during life.

There is no change in the density of the spiral ganglion. The condition of the cochlea is shown in fig. 8.

The organ of Corti.—There is considerable post-mortem degeneration, but the cells are otherwise normal (fig. 9).

The stria vascularis.—This is normal apart from severe post-mortem degeneration.

The aqueduct of the cochlea.—This is normal and patent throughout its length.

The saccus endolymphaticus.—As in the right temporal bone the lumen is for the most part collapsed. Elsewhere, it is reduced to numerous small vesicles which are tightly packed with red-staining colloid material. In addition there is a conspicuous absence of the normal perisaccular connective tissue, and the lining epithelium lies everywhere in close contact with the dense material of the surrounding dura mater.

The condition of the saccus is shown in fig. 10.
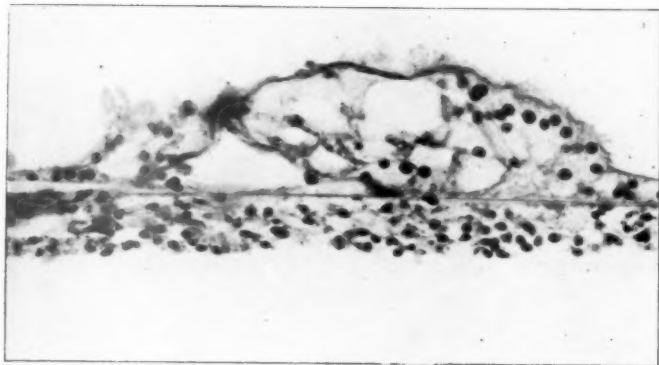
FIG. 9.—Left temporal bone. The organ of Corti showing post-mortem degeneration.
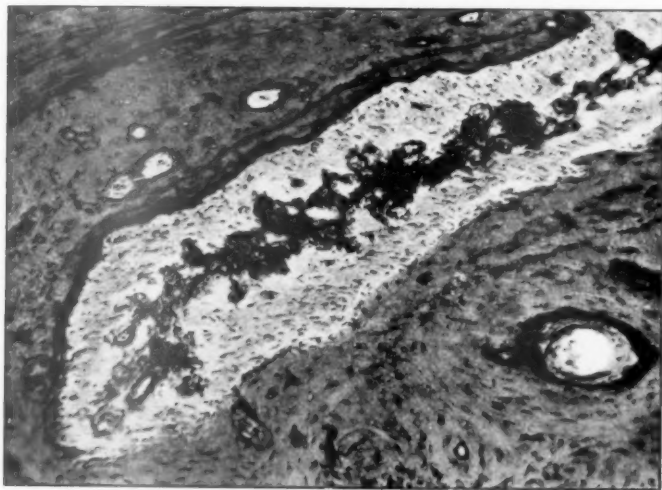
FIG. 10.—Left temporal bone. The saccus endolymphaticus, showing absence of the "normal" peri-accular connective tissue, and dense red-staining colloid material within the lumen.

Internal auditory meatus and 8th nerve.—The nerve has been cut across approximately at the main neurilemmal-neuroglial junction. There are no abnormalities of size or structure of its fibres.

In the fundus of the meatus there is some albuminoid coagulum, with a few collections of red cells and scattered small lymphocytes. The number of these cells is small and their pathological significance doubtful.

Examination of the 7th and 8th nerves between the internal auditory meatus and the brain-stem showed no abnormalities.

DISCUSSION

In a previous communication by Hallpike and Cairns [1] the following summary was given of the pathological changes in the affected temporal bones of the two subjects concerned :—

" In both there was a gross dilatation of the endolymph system affecting chiefly the scala media of the cochlea and the saccule. Degenerative changes were present in Corti's organ in both cases and in the stria vascularis in the second case only. In addition, the loose connective tissue surrounding the saccus endolymphaticus described by Guild as the normal area of endolymph absorption was absent in both cases."

Upon this morphological evidence the view was advanced that the primary mechanism of the disease was an obstructive distension of the endolymph system. No evidence was found in support of the suggestion that the changes represented an inflammatory reaction, and a second possibility that they were in some way dependent upon the operation of intracranial section of the 8th nerve was likewise considered to be excluded by the absence of comparable changes in cases of death following other intracranial operations including operations for the removal of 8th nerve tumours. The rejection of these two possibilities is certainly supported by the results of the present investigation ; firstly, by the conspicuous absence of inflammatory changes and secondly by the occurrence of the essential endolymphatic dilatation in the absence of any antecedent intracranial surgical procedure. With the occurrence therefore in the present instance of this distension, in the absence once again of the normal perisaccular connective tissue the essential characters of the changes previously described appears to have been reproduced with considerable fidelity ; and in the view of the peculiar nature of these changes, it follows that their demonstration in three successive subjects makes it reasonable to regard them as constituting the essential morbid anatomy of a specific disease of the labyrinth.

It remains to consider in greater detail the relatively slight degree of the endolymphatic distension in the present instance and the absence of changes in Corti's organ or in the stria vascularis such as were disclosed in both of the cases previously reported. In both particulars it seems likely that the principal factor involved was the short duration of the disease ; six months only having elapsed between the first attack of vertigo and death. With regard to the extent of the endolymphatic distension it must be recalled that in the two previous cases the blocking of the scala vestibuli by the distended scala media was complete and this, it was suggested, was an essential part of the mechanism of the vertiginous attacks.

This suggestion does not appear to be supported by the finding in the present subject of an incomplete distension of Reissner's membrane. Nevertheless, the possibility clearly exists that the distension found might well be subject to a rapid increase to the point of complete obliteration of the scala vestibuli and that such an increase might occur within a prodromal period of some hours preceding an attack

of vertigo. This possibility is supported by the finding as already described of marked folds in Reissner's membrane and for this reason it does not seem necessary at present to discard the suggestion in question.

As to the absence in the present subject of changes in Corti's organ or in the stria vascularis, it seems obvious that in addition to the minor character of the histological changes which would be likely to occur in the early stages of the disease, account must also be taken of a certain transience of these changes which would well accord with the fluctuating character of the deafness emphasized by Crowe [3]. It follows that such transience on the part of the changes in Corti's organ introduces a chance factor which would play an important part in determining the results of histological examination. Should this factor operate unfavourably then it seems likely that the minor changes which may be present in Corti's organ in the early stages of the disease will always defy histological demonstration, particularly when, as in the present instance, they are further obscured by the artefacts of post-mortem degeneration.

Acknowledgment is made to the Directors of the Ferens Institute, Middlesex Hospital, for kindly providing facilities for this investigation and to the skill of the laboratory staff in carrying out the histological and photographic work.

REFERENCES

1 HALLPIKE, C. S., and CAIRNS, H., *Proc. Roy. Soc. Med.*, 1938, **31**, 631, 1317 (Sect. Otol., 55) ; *J. Laryng. & Otol.*, 1938, **53**, 625.
2 GUILD, S. R., *Am. J. Anat.*, 1927, **39**, 57.
3 CROWE, S. J., *Medicine*, 1938, **17**, 1.

Mr. Terence Cawthorne did not think these cases of vertigo suffered from water retention as was suggested by Dederding and Mygind, but it was possible that in ears affected in the way that had just been described, there was some interference with the normal drainage mechanism whereby they were more sensitive to changes of fluid balance in the body, and this made them unable to compensate for the sudden changes that might occur from time to time. He had found in a series of cases that at least half of them responded favourably to a strict anti-retentional régime.

Mr. Stirk Adams said this extremely important record showed that the lesion causing the attacks was something which produced failure of absorption of the endolymph and a glaucoma of the labyrinth. It was interesting that this glaucoma was associated with a general hearing loss throughout the tone scale, while section showed a normal cochlea. He asked if Mr. Hallpike could say whether the basal ganglia and the 8th nerve were also normal, as if this was the case we could regard glaucoma of the labyrinth as entirely responsible for this hearing loss.

He would like to ask Mr. Wright to complete the scientific records by telling him whether binaural diplacusis was found in the original hearing tests.

He would also like to mention the work of Shambaugh of Chicago (*Arch. Oto-Laryngol.*, **26**, No. 5, 601) who found diplacusis present in cases of acute aural vertigo, which disappeared when the patient recovered as a result of treatment of a toxic focus.

Mr. Hallpike (in reply to Dr. Kerridge) said that the temporal bones were put into formalin about twenty hours after death. The section showed well marked distension of the endolymphatic system in the cochlea and a fibrotic condition of the endolymphatic absorption area.

In reply to Mr. Woodman who asked what was the cause of death in the other two cases mentioned, Mr. Hallpike said that they died after a section of the 8th

nerve. He also said that although there was sepsis in the middle ear there was nothing in the least suggestive of labyrinthitis. There was granulation tissue in the round window niche but no signs of permeation of the membrane.

Mr. Musgrave Woodman said that he thought this was a very useful investigation, but it was well to point out that many of these cases had drastic symptoms and yet were cured in quite a simple way. Therefore it could not be a permanent pathological lesion or condition.

Mr. Hallpike said that he did not think all the morphological changes which were probably present during a vertiginous attack remained, but certain things did remain, including the stretching of Reissner's membrane, and these were sufficient, or so it was hoped, to indicate the essential mechanism of the disease.

Section of Urology

President—H. P. WINSBURY-WHITE, F.R.C.S.

[*May* 26, 1939]

DISCUSSION ON LATE RESULTS OF CONSERVATIVE TREATMENT OF HYDRONEPHROSIS

Mr. E. W. Riches: *Pathology.*—It must be recognized that whilst some cases of hydronephrosis are due to a well-defined mechanical obstruction of the ureter, there are others, which may be called dynamic, in which no such obstruction can be found ; it is presumed that they are due to some neuromuscular defect, a view supported by von Lichtenberg (1929) and Harris (1935). The experimental evidence brought forward by Underwood (1937) lends further support to the belief that the defect is due to sympathetic over-activity. As a dynamic hydronephrosis progresses, other factors come into play which will increase its size by mechanical obstruction. These secondary causes, among which are pressure from vessels, renal ptosis, ureteral stenosis or adhesions, are often the determining factors in producing complete hydronephrotic atrophy ; their removal or correction will lead to a limited degree of improvement. This report deals with the dynamic cases, and in particular with those where the defect is at the pelvi-ureteric junction.

Indications for conservative surgery.—One of the best reasons for choosing conservative surgery is the desire to preserve a useful organ in cases where the kidney can be so repaired as to be able to maintain life, should the other be lost. Hydronephrosis is a progressive disease, and Sargent (1937) has pointed out that potentially at least it is a bilateral affliction ; in this series 11% of the cases were bilateral. The rare cases of solitary kidney, of which there was one in this series, seem particularly prone to hydronephrosis. Many cases affect children or young adults, or women in the child-bearing period in whom nephrectomy is undesirable.

Contra-indications.—Gross infection which cannot be controlled in some measure before operation usually contra-indicates conservative surgery, as does complete loss of function, but if a kidney is capable of excreting any dye during excretion urography it may be worth saving. Intrarenal as opposed to pelvic dilatation is less suitable for conservative measures. The actual size of the sac is of less importance than the degree of infection, and many of the larger hydronephroses show a more striking response than the smaller ones.

Methods of investigation.—Except for two cases of painless hæmaturia, all these patients sought advice for intermittent attacks of pain in the loin often with vomiting. Where the clinical findings are suggestive, the first positive diagnosis is usually made

by excretion urography, but complete urological examination is necessary. The essential and desirable investigations are :—

Essential	Desirable
Excretion urography.	
Instrumental pyelography :	Pelvic capacity.
(*a*) If excretion is poor.	Pelvic content (residual).
(*b*) To demonstrate reproduction of pain.	Emptying time.
Urine : Bacteriological.	
Renal Function :	
By excretion urography.	Dye excretion.
Blood urea.	Specific gravity and urea content of kidney urines.

Criteria of success.—The assessment of the results of conservative operations must be made not only on clinical grounds but also from the radiological, functional, and bacteriological viewpoints. A pelvis which has been made smaller or more contracted and systolic in type will also fill earlier and empty more rapidly on excretion urography and there will no longer be evidence of the progressive renal damage which was formerly apparent.

Urinary infection should be absent, and with it urinary symptoms, and these results should be permanent over a number of years. This high ideal is not always reached, and from a large hydronephrosis it is impossible to produce a normal kidney, but the result can still be classified as good if these criteria are fulfilled. The radiological and bacteriological findings give a good index of the clinical result, and except in a few cases where there is a transient dilatation the initial result usually remains permanent. For this reason cases operated upon up to December 1938 have been included in the series reported. The methods employed and results obtained are given in Table I :—

TABLE I.

	No. of cases	Good results
(1) Division of vessels ..	6	6
(2) Minor plastic operations	4	3
(3) Major plastic operations	31	19
(4) Sympathectomy ..	13	11
	54	39 = 72%

Secondary nephrectomy: 5 = 9·2%.
Operative mortality: Nil.

The results have been classified as good, fair, or poor, according to the combined clinical, radiological, and bacteriological findings. Some overlapping of the groups is inevitable, but each case is included in the group which describes what was considered to be the main therapeutic measure employed. Nephropexy and partial decapsulation have been added in certain cases.

(1) DIVISION OF VESSELS

The part played by so-called aberrant vessels in the production of hydronephrosis is still debatable. Whilst many American observers place it first on the list of causes (Stevens, 1930 ; Lubash and Madrid, 1937), the tendency in this country has been to regard these vessels as secondary obstructive factors (Pannett, 1922 ; Winsbury White, 1925). In this series vessels have only been divided which were producing obvious obstruction and were adherent to the pelvi-ureteric junction by surrounding fibrosis.

TABLE II.—DIVISION OF VESSELS.

Case No.	Sex	Age	Grade and side	Infection Pre-operative	Infection Post-operative	Period since operation Years	Period since operation Months	Symptomatic result	Radiological result	Remarks
V.1	F.	38	1 R.	—	—	5	10	Good	Good	
2	F.	22	2 L.	+	—	4	11	Good	Good	Polar artery
3	M.	28	3 R.	+	—	4	9	Good	Good	
4	M.	24	3 R.	—	—	4	8	Good	Good	Polar vessels ; recurrent hæmorrhage three years later
5	M.	35	3 L.	—	—	4	2	Good	Good	Calculous ; pelvis resected
6	F.	13	2 R.	+	—	3	4	Good	Good	Polar artery

This case is an example :—

Case report.—Male aged 28. Pain in right loin ten years.

Urine infected with *B. coli* and *B. proteus.* Operation in September **1934**, division of vascular fibrous band containing an artery and two veins, nephropexy. Four years nine months later no return of symptoms, urine sterile.

In one case, a hydronephrosis with secondary stone formation, the pelvis was reduced in size by resection of its posterior part and the vessel divided (V.5).

In one case there was a return of pain with an attack of hæmaturia three years after operation ; this lasted only a few days and has not been repeated up to four years and eight months ; the radiological result was still satisfactory.

(2) MINOR PLASTIC OPERATIONS

I have used this term to describe those operations in which the pelvi-ureteric junction is enlarged without complete separation of the ureter from the pelvis. Fenger's operation (1894) is the oldest and simplest and has been used in a series of four cases, but with the addition of a splint-nephrostomy catheter in the last three.

TABLE III.—MINOR PLASTIC OPERATIONS (FENGER).

Case No.	Sex	Age	Grade and side	Infection Pre-operative	Infection Post-operative	Period since operation Years	Period since operation Months	Symptomatic result	Radiological result	Remarks
F.1	F.	29	1 R.	—	—	8	5	Good	Good	Stenosis following pyelotomy
2	M.	36	1 L.	—	—	6	2	Good	Good	
3	F.	39	1 R.	—	—	6	1	Good (1 yr.)	Good	
4	F.	32	2 R.	+	±	5	7	Fair	Fair	

Case 1 has previously been shown to this Section (Riches, 1931).

This case (F.2) is typical :—

Case report.—Male aged 36. Attacks of pain in left loin two and a half years, with hæmaturia and frequency. Albuminuria discovered at life assurance examination ; referred for two years. Operation, April 1933, fibrosis at pelvi-ureteric junction. Fenger's operation with splint-nephrostomy catheter for twelve days. Four years later no return of symptoms, no albuminuria ; accepted as first-class life by same doctor and Company.

One case remained infected for several years, but the urine has now been sterilized by ammonium mandelate (F.4).

This type of operation is suitable for the smaller hydronephroses, especially when associated with some stenosis of the pelvi-ureteric junction. I have used Foley's " Y plasty " in one case where there was stenosis following a major plastic operation, and the result promises to be satisfactory. Foley (1937) reported the results of twenty such operations with two deaths and sixteen good results ; he found that the disappearance of the pelvic dilatation had not been all that could be desired in every case, and in the larger hydronephroses it would appear wise to reduce the size of the sac by resection if stagnation and infection are to be avoided.
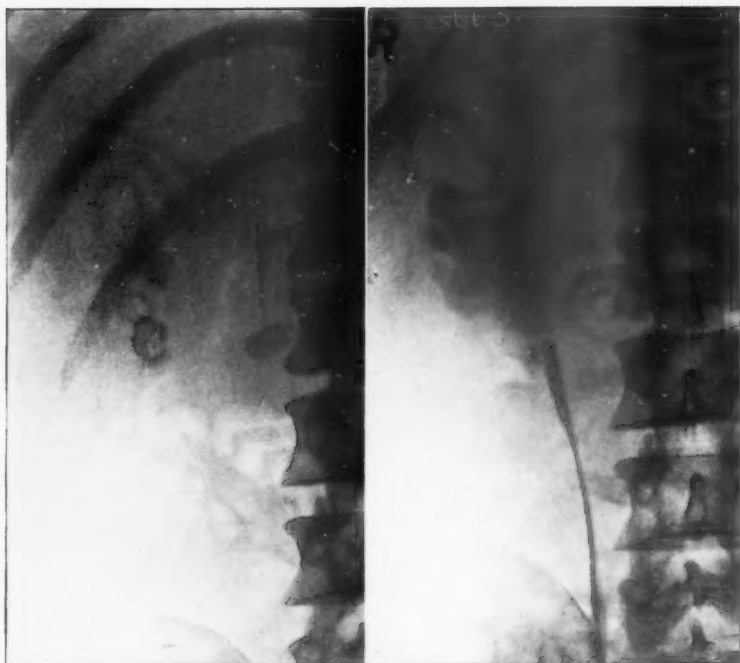
A   B
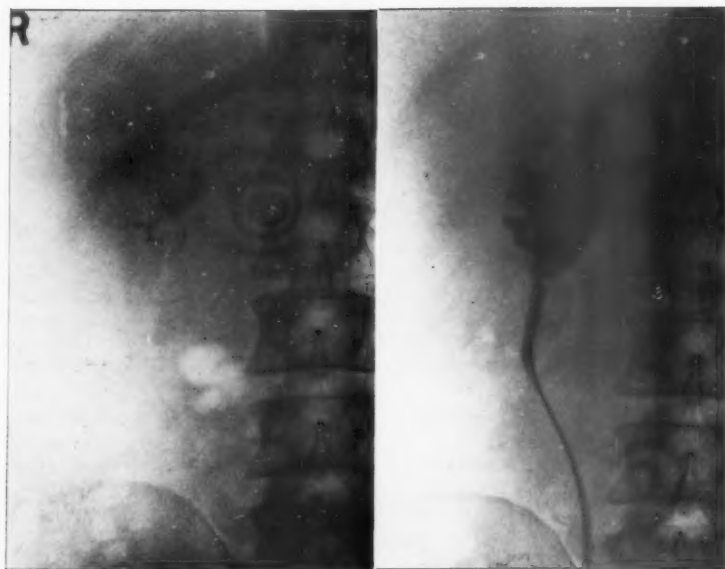
C   D

Fig. 1 (Case V.3).—A. Pre-operative excretion urogram, twenty-minute film. Poor secretion and clubbed calyces on right; B. Pyelogram confirms hydronephrosis Grade 3; C. Excretion urogram, fifteen-minute film, three years eight months after operation, good concentration, calyces cupped; D. Pyelogram, three years eight months after operation, pelvis smaller, free entrance to catheter at pelvi-ureteric junction.
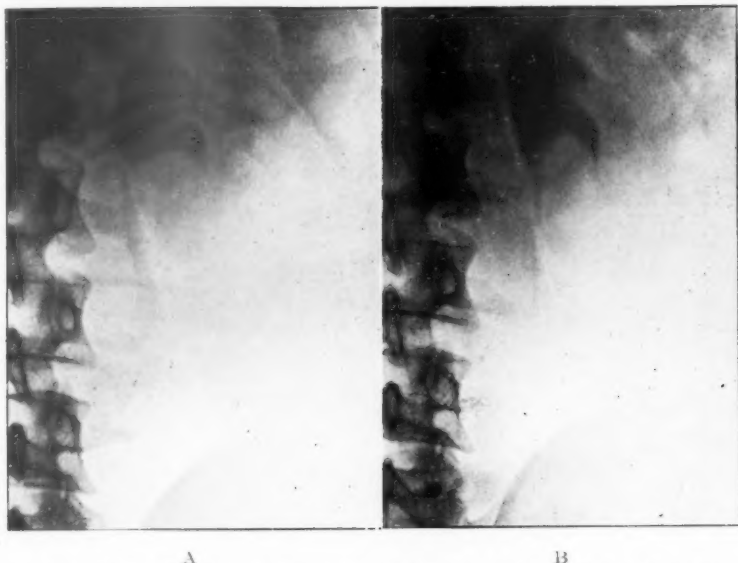
A   B

FIG. 2.—A. Pre-operative excretion urogram, one-hour film, left hydro-nephrosis, Grade 1 ; B. Excretion urogram, fifty-five-minute film, six months after operation, smaller pelvis and better emptying.

(3) MAJOR PLASTIC OPERATIONS

Here the ureter is deliberately divided and the pelvis resected. The operation used in this series was that described by von Lichtenberg (1929) and demonstrated by him at St. Paul's Hospital in 1931. It consists of resection of the pelvi-ureteric junction and redundant pelvis with re-anastomosis of the ureter over a splint catheter into the lowest part of the new pelvis ; a second nephrostomy tube and a drain down to the junction are essential. In this technique a small cuff of ureter is left projecting into the pelvis, and this cuff has been criticized as being likely to form a valve at the new junction (Walters, 1933 ; Ormond, 1936). I have seen a mucous valve following it once ; it did not produce complete obstruction, but formed a ring of redundant mucosa just below the pelvi-ureteric junction which prevented a catheter being passed into the pelvis. It was a case of solitary kidney, and as he was getting frequent attacks of pain I re-explored the loin four years after the original operation and did a Foley " Y plasty " operation ; he has remained free from pain since nearly four months later, and the kidney now secretes uroselectan at forty-five minutes. In three cases where I have removed the kidney later on account of persistent infection, there has been stenosis at the junction, but no evidence of valve formation.

Table IV gives a summary of the results, and further details are given in Table V.

TABLE IV.—MAJOR PLASTIC OPERATIONS.

Total number of cases = 31.

Results : Good 19 (61%).   Fair 4.   Poor 8 (including 5 secondary nephrectomies)

Operative mortality	.. ..	Nil
Infected cases ..	.. ..	17 (55%)
Good result in 9 (53%)		
Non-infected cases	.. ..	14 (45%)
Good result in 10 (71%)		

TABLE V.—MAJOR PLASTIC OPERATIONS.

Case No.	Sex	Age	Grade and side	Infection Pre-operative	Infection Post-operative	Period since operation Years	Months	Symptomatic result	Radiological result	Remarks
P.1	F.	60	1 L.	+	±	8	2	Good	Good	Calculous
2	M.	24	2 R.	+	−	8	1	Good	Good	
3	M.	23	2 R.	+	+	6	0	Fair	Poor	
4	F.	38	2 R.	+	−	6	0	Good	Fair	Pelvis not resected
5	M.	33	3 R.	+	+	5	9	Poor	Poor	Nephrectomy three years later
6	M.	13	2 L.	−	+	4	5	Fair	Poor	Solitary kidney ; Y plasty four years later
7	F.	31	3 R.	+	−	4	1	Good	Good	
8	F.	58	1 R.	−	−	3	8	Good	Good	
9	F.	22	2 R.	+	−	3	8	Poor	Poor	Nephrectomy eight months later
10	M.	47	2 R.	+	+	3	6	Good	Good	
11	F.	22	3 L.	+	−	3	3	Good	Good	Normal pregnancy
12	F.	54	2 L.	+	∓	3	3	Good	Good	Vesical infection two and a half years later
13	M.	13	2 R.	−	+	3	3	Poor	Poor	Nephrectomy three months later
14	F.	11	3 L.	−	−	3	1	Good	Good	
15	F.	28	3 L.	−	−	3	0	Good	Good	
16	F.	36	3 R.	+	−	2	10	Good	Good	Hydro-ureter
17	F.	64	2 L.	+	+	2	7	Fair	Fair	Recurrent pyelitis
18	F.	20	3 R.	−	−	2	7	Fair	Fair	Return of pain two years later
19	M.	12	3 L.	+	+	2	5	Good	Fair	
20	F.	51	2 L. 1 R.	−	−	2	2	Good	Good	
21	F.	59	2 R.	−	−	1	5	Good	Good	Double kidney
22	F.	36	2 L.	−	+	2	0	Fair	Poor	Staph. infection
23	F.	47	3 R.	−	?	1	8	Good	Good	
24	F.	23	3 L.	−	−	1	8	Fair	Good	
25	M.	63	2 L. 2 R.	+	+*	0	5	Good	Good	L. conservative. R. nephrectomy five months later. Died
26	M.	28	3 R.	+	−	1	0	Good	Good	
27	M.	45	1 L.	−	−	0	10	Poor	Poor	Nephrectomy eighth day ; secondary hæmorrhage
28	F.	28	2 L.	−	−	0	9	Good	Good	
29	F.	44	2 R. 1 L.	+	+	0	8	Poor	Poor	Double kidneys ; nephrectomy three months later
30	M.	42	2 R.	−	+	0	8	Good	Good	
31	F.	57	3 R. 3 L.	−	−	0	5	Good	Good	

* Infection from opposite kidney.

Of the five cases in which secondary nephrectomy was performed, four were for persistent infection and one for secondary hæmorrhage on the eighth post-operative day.

The results are not so good numerically as those of the other groups, but it must be remembered that 55% had a pre-operative infection and that the group includes cases in which the possibility of conservative surgery at all was doubtful. Nevertheless it is felt that the number of advanced cases in which the kidney was restored to a useful function fully justifies the group as a whole. Two of the patients were treated over eight years ago and are still alive and well.

One of the factors militating against a successful result has been pre-operative infection, and unless this can be controlled, post-operative stenosis of the junction is liable to occur ; its control has been made easier since the advent of the mandelates and of sulphanilamide. Post-operative infection was in some cases difficult to control and usually followed blockage of the catheters by blood-clot. I believe that the use of mercurochrome for lavage as advised by Bailey (1936) is advantageous, and I usually give a course of ammonium mandelate or of sulphanilamide soon after operation.

One case will be shown in some detail as it indicates how the normal peristaltic wave down the ureter is gradually re-established ; six weeks after operation the

ureter was still dilated, but at seven months it was normal and the pyelogram at two and a half years shows that the improvement in the kidney is maintained.

Case report.—Female aged 28. Pain in left loin three years; urine sterile. Operation June 1936, inferior vessels crossing in front of ureter, not divided; resection of pelvis and re-implantation of ureter. Catheters came out on fourth day. Two and a half years later no return of symptoms; urine sterile.
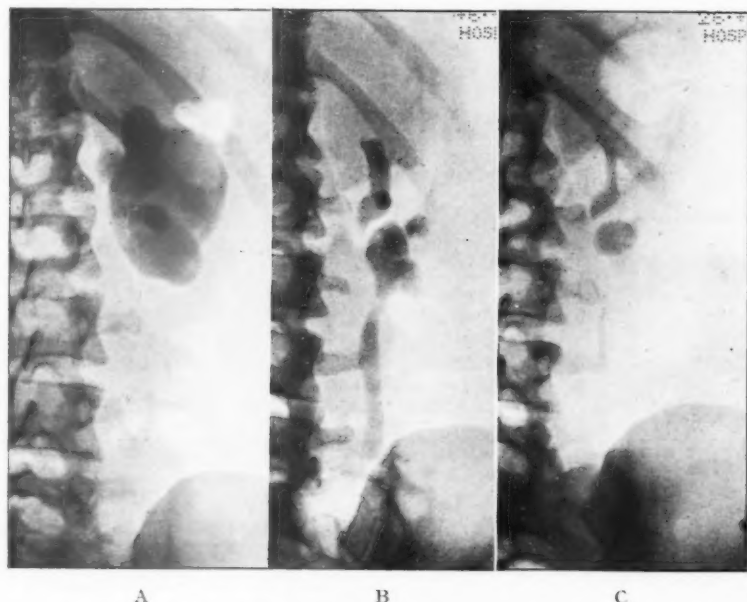

A   B   C

FIG. 3 (Case P.15).—A. Pre-operative excretion urogram, forty-five-minute film; B. Excretion urogram, thirty-minute film, six weeks after operation; pelvis is smaller, but ureter still dilated; C. Excretion urogram, five-minute film, seven months after operation; pelvis and ureter now appear normal.

Throughout the series the excretion urograms give the best indication of the renal function; artificial distension by pyelography frequently reveals that the calyces can still be dilated.

Case P.11 is an infected case in which there was no excretion of uroselectan up to forty-five minutes, but where about half the kidney substance remained. She has come through one normal pregnancy and is now eight months pregnant again.[1] The kidney is still dilated, but its function is useful :—

Case report.—Female aged 22. Pain in left loin six years with vomiting; frequency and polyuria. Urine infected with *B. coli*. Operation March 1936, inferior vessels passing in front of ureter, but not divided; about one-half of kidney substance remaining. Resection of pelvis and re-implantation of ureter, decapsulation of upper half of kidney. One year seven months later normal pregnancy. Now three years two months later pregnant again, no return of symptoms, urine sterile.

[1] This pregnancy terminated normally without return of symptoms.
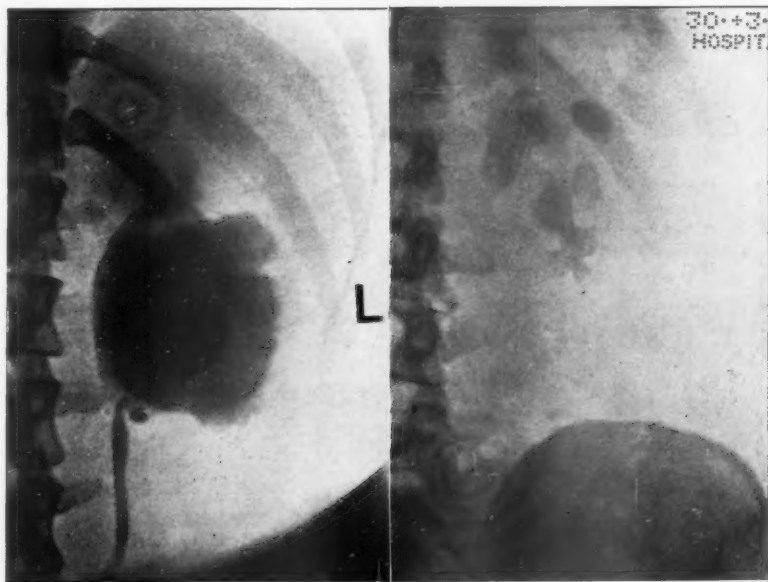
FIG. 4 (Case P.11).—A. Pre-operative excretion urogram, no excretion on left
side at forty-five minutes; B. Pre-operative pyelogram, hydronephrosis, Grade 3;
C. Excretion urogram one year after operation, thirty-minute film, better
concentration and less clubbing of calyces.

In the next case the kidney was removed at autopsy five months later and shows the actual appearance of a successful case.

Case report (P.25).—Male aged 63. Sudden pain in left loin with vomiting. Left kidney enlarged and tender, urine infected with *B. proteus* ; blood urea 95 mgm. %. Operation October 1937, resection of left pelvis and re-implantation of ureter. Five months later no further pain on left side, but infection persisted from right side in which there was now a stone. Right nephrectomy was followed by death two days later. The right kidney was grossly infected. Post-mortem showed acute dilatation of the stomach and myocardial degeneration. The left kidney showed a wide pelvi-ureteric orifice and no signs of inflammation in the pelvis which was contracted.

Where there is a bifid pelvis with two major calyces separated by a long projecting process, a wider margin of pelvis should be left adjoining the kidney ; failure to recognize the condition led to an unsatisfactory result in one case.

Where symptoms have been present for many years the calyces become grossly clubbed and they will not return to normal ; this may lead to stasis and infection later on ; the next case illustrates this point :—

Case report (P.18).—Female aged 20. Pain and swelling in right side ten years. Operation November 1936, resection of pelvis and re-implantation of ureter ; upper polar vessel and normal inferior vessels, neither divided. Two years later no further symptoms, but after two years and one month occasional pain returned. The urine was sterile.

The main causes of failure have been :—
(i) Uncontrolled pre-operative infection.
(ii) Post-operative infection following blockage of the catheters by blood-clot.
(iii) Possibly pressure anæmia of the ureter from too large a splint catheter.
Any of these factors may lead to post-operative stenosis of the junction.
(iv) Bifid pelvis.
(v) Secondary hæmorrhage.

A   B
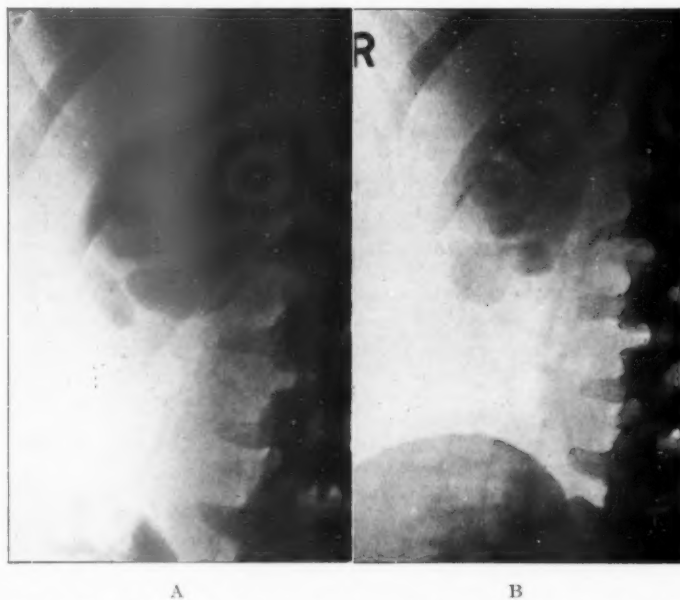
Fig. 5 (Case P.18).—A. Pre-operative excretion urogram, thirty-minute film;
B. Excretion urogram two and a half years after operation, ninety-minute film.

(4) RENAL SYMPATHECTOMY

If it is correct that the primary fault is one of sympathetic over-activity, it should be possible to cure the earliest cases by sympathetic denervation. Whether the method of stripping the renal pedicle is the best, remains to be seen. The results of this operation in 13 cases are given in Tables VI and VII.

TABLE VI.—SYMPATHECTOMY.

Total number of cases = 13.

Results : Good 11 (85%).   Fair 2.
       Nephropexy in 3.   Aberrant vessels present in 2.   Pre-operative infection in 8.
                       All sterilized after operation.

TABLE VII.—SYMPATHECTOMY.

Case No.	Sex	Age	Grade and side	Infection Pre-operative	Infection Post-operative	Period since operation Years	Period since operation Months	Symptomatic result	Radiological result	Remarks
S.1	F.	34	1 R.	+	—	4	2	Good	Good	Pelvis at first larger
2	F.	31	1 R.	—	—	4	0	Fair	Fair	Re-dilatation in pregnancy
3	M.	31	1 R. 4 L.	+	—	3	4	Good	Good	L. nephrectomy six weeks later
4	F.	34	1 R.	±	—	3	2	Good	Good	Now pregnant
5	M.	29	1 L.	—	—	2	8	Good	Good	Aberrant vessels divided
6	F.	30	1 R.	±	—	2	7	Good	Good	
7	M.	22	1 R.	—	—	2	5	Good	Good	
8	F.	35	1 R.	+	—	1	11	Good	Good	
9	F.	59	1 R.	+	—	1	10	Good	Good	Nephropexy
10	F.	19	1 R.	±	—	1	8	Good	Good	Normal pregnancy
11	F.	35	1 R.	—	—	1	8	Fair	Good	Nephropexy
12	F.	38	1 R.	—	—	0	8	Fair	Good	Nephropexy. Pain recurred after an accident
13	F.	22	1 R. 1 L.	±	—	0	6	Good	Good	Appendicectomy and cholecystectomy

The radiological results are not so striking as in the other groups, but generally there is a more contracted systolic appearance of the pelvis on excretion urography and the smaller pelvic content on instrumental pyelography. Clinically the most striking feature is the abolition of renal pain even on pyelography. In only one case the pain recurred after a bus accident and has persisted for four months despite a satisfactory radiological appearance. In one the dilatation recurred during pregnancy and necessitated medical induction at eight months.

This is a typical case :—

Case report (S.8).—Female aged 35. Pain in right loin four years and increased frequency of micturition. Urine infected with *B. coli*. Ureteric catheter drainage and lavage three times with temporary relief ; urine sterilized by ammonium mandelate but infection recurred quickly. Operation August 1937, right renal sympathectomy. One year nine months later no return of pain ; urine sterile.

In some cases the urine was sterilized by treatment before operation but the pain remained, and in others the infection recurred. The persistence of freedom from urinary infection after operation in the eight cases previously infected is an index of the improvement in kidney function.

The fact of clearing up infection alone may result in an improved radiological appearance.

Where the kidney was low, nephropexy was performed as well as sympathectomy ; similar improved radiological results may be obtained by nephropexy alone, but my acquaintance with that operation has led me to decide never to do it without doing a sympathectomy at the same time. Multiple lesions may confuse the diagnosis of right sided pain, but the exact reproduction of the pain on pyelography is an

important feature in the diagnosis of its cause. In one such case the previous removal of a calculous gall-bladder left the pain unaltered. In another where the appendix and gall-bladder were both diseased I removed them at the time of the renal sympathectomy and the result up to six months is satisfactory.
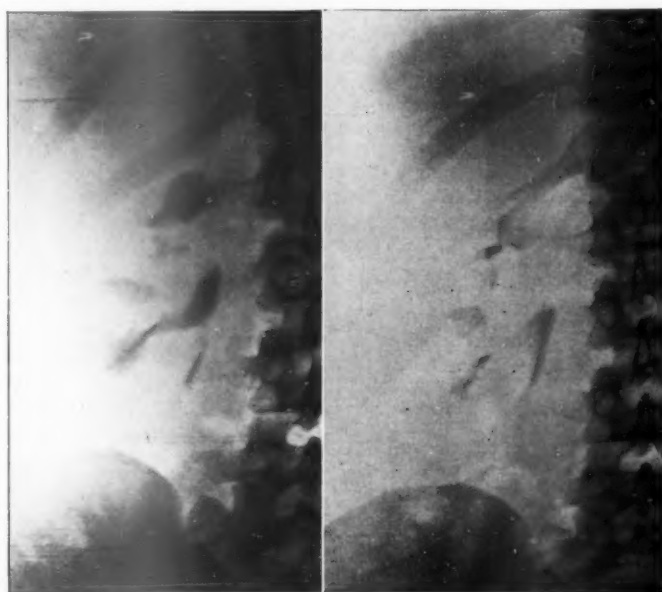

A   B
FIG. 6 (Case S.8).—A. Pre-operative excretion urogram, thirty-minute film;
B. Excretion urogram nine months after operation, thirty-minute film.

The earliest case, operated upon over four years ago has remained well and the urine previously infected with *B. coli* is now sterile.

COMPARISON WITH OTHER REPORTED SERIES

Quinby (1927) reported 13 cases of conservative treatment including seven of transplantation of the ureter with success. Von Lichtenberg (1929) reported 47 cases with secondary nephrectomy in 7%. Walters, Cabot and Priestley (1937) reported 71 cases from the Mayo Clinic with an operative mortality of 2·8%, and secondary nephrectomy in 21%; of the remaining 46, 71·7% benefited by the operation.

CONCLUSIONS

In cases of hydronephrosis unless the kidney is grossly infected or badly damaged conservative surgery is applicable. Before operation an attempt should be made to control infection in all cases. The exact surgical procedure to be adopted can only be decided at the time of operation but the following appear to be suitable :—

In a small hydronephrosis.—(a) In the absence of mechanical obstruction, renal sympathectomy.

(*b*) In the presence of mechanical obstruction, its correction or removal. This may include the division of obstructing vessels of moderate size.

(*c*) In the presence of ureteral stenosis, a minor plastic operation.

In a large hydronephrosis.—(*a*) Where infection is absent or can be controlled before operation, a major plastic operation.

(*b*) If otherwise, nephrectomy, if remaining kidney is sound. Sympathectomy may be combined with any of the other conservative procedures, and nephropexy or partial decapsulation may be advisable.

My thanks are due particularly to the radiologists and pathologists, and to my colleagues who have referred cases to me. I am indebted to the Principal Medical Officer of the London County Council for permission to include cases P.19 and P.26, and to Dr. A. D. Morris for the notes on the subsequent progress of case S.2.

BIBLIOGRAPHY

BAILEY, H. (1936), *Brit. M. J.* (ii), 669.
FENGER, C. (1894), *J. A. M. A.*, **22**, 335.
FOLEY, F. E. B. (1937), *J. Urol.*, **38**, 643.
HARRIS, S. H. (1935), *Proc. Roy. Soc. Med.*, **28**, 1497 (Sect. Urol., 59).
LUBASH, S., and MADRID, A. (1937), *J. Urol.*, **38**, 634.
ORMOND, J. K. (1936), *ibid.*, **36**, 512.
PANNETT, C. A. (1922), *Brit. J. Surg.*, **9**, 509.
QUINBY, W. C. (1927), *J. A. M. A.*, **89**, 84.
RICHES, E. W. (1931), *Proc. Roy. Soc. Med.*, **24**, 1231 (Sect. Urol., 38).
SARGENT, J. C. (1937), *J. Urol.*, **38**, 680.
SCHWYZER (1923), *Surg. Clin. N. America*, **3**, 1441.
STEVENS, A. R. (1930), *J. Urol.*, **23**, 493.
UNDERWOOD, W. E. (1937), *Proc. Roy. Soc. Med.*, **30**, 817 (Sect. Urol., 43).
VON LICHTENBERG, A. (1929), *J. A. M. A.*, **93**, 1706.
Id. (1921), *Ztschr. f. Urol. Chir.*, **6**, 284.
WALTERS, W., CABOT, H., and PRIESTLEY, J. T. (1938), *J. Urol.*, **38**, 688.
WALTERS, W. (1933), *ibid.*, **29**, 121.
WINSBURY-WHITE, H. P. (1925), *Brit. J. Surg.*, **13**, 247.

Mr. Victor Dix: My conclusions about the late results of conservative operations for hydronephrosis are based on sixty cases of hydronephrosis on which I operated before July, 1938. Of these sixty cases, thirty-four had radical operations, and twenty-six conservative operations, of four different types.

OPERATIONS ON HYDRONEPHROSIS.

Total number of cases .. 60

Radical operations :

Nephrectomy	..	..	..	..	..	32 cases
Nephro-ureterectomy	..	..	..	..		2 cases
					34 cases

Conservative operations :

Ligature and division of lower pole vessels	..	..	..	6 cases
Excision of pelvis and re-implantation of ureter (von Lichtenberg)	..		10 cases
Conservative procedure and temporary nephrostomy	..	..	8 cases
Re-implantation of ureter into bladder	..	..	..	2 cases
			26 cases

It is of the greatest importance to include the radical operations performed during the same period in any assessment of the value of conservative operations. It is only when these are included that we can tell in what proportion of cases the surgeon has elected to take the risk of obtaining a bad result in order to achieve, if possible, a complete restoration to normal. It is of little value to save a kidney which will never perform more than a small fraction of its original function, and it is at least

arguable that nephrectomy is preferable to any operation which does not result in an almost perfect restoration of function. Most of us will agree that nephrectomy has certain obvious advantages, of which perhaps the most important is the assurance that the patient will be cured and that no further operation will be necessary.

I propose to mention operative technique only in so far as it is necessary to make clear exactly what operations I have done, and to show pre- and post-operative pyelograms illustrating the results obtained after each type of operation. The four types of operation I have performed are set out above.

Ligature and division of lower pole vessels.—It is my firm conviction that lower pole vessels can really cause obstruction and hydronephrosis and that they are therefore in many cases a primary and not a secondary factor. As to the technique of the operation of ligature and division of lower pole vessels I should like to emphasize that I do not necessarily make an extensive dissection, if I find an abnormal lower pole vessel which is obviously obstructing the pelvis. It is therefore difficult to see how my results can be due to an involuntary peri-arterial sympathectomy and not in fact to the division of the obstructing vessel.

RESULTS OF LIGATURE AND DIVISION OF LOWER POLE VESSELS: 6 CASES.

Free from symptoms (6 cases)

Pyelogram normal	..	..	..	..	4 cases (3 : 3 : 3 : 1)
Pyelogram improved	..	..	..	..	1 case (1½)
Pyelogram improved on fifteenth day : not done again			..	1 case (2¾)

Here are two results : one with a normal post-operative pyelogram (figs. 1 and 2), the other with an improved but still abnormal pyelogram (figs. 3 and 4).

Excision of pelvis and re-implantation of ureter (von Lichtenberg).—It was my good fortune to see this operation performed several times by Professor von Lichtenberg when I was at his Clinic in Berlin in 1930. I performed it myself for the first
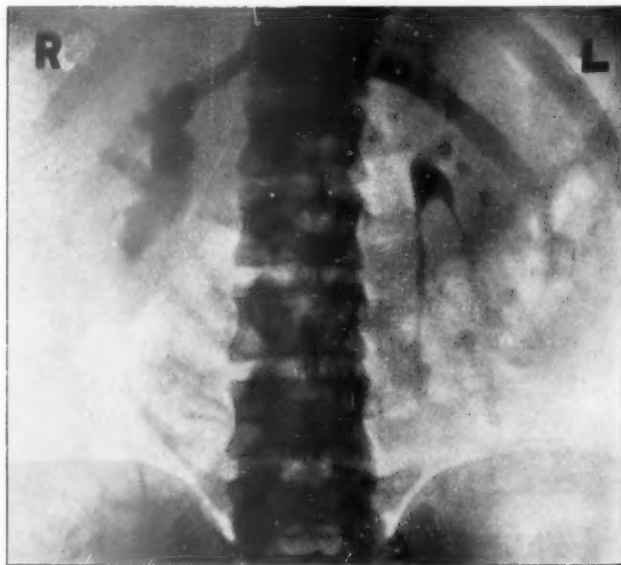
FIG. 1.—Patient A. B. Pre-operative excretion pyelogram, fifteen-minute film.

FIG. 2.—Patient A. B.　Excretion pyelogram three years after operation.

FIG. 3.—Patient G. K.　Pre-operative pyelogram.

FIG. 4.—Patient G. K.　Pyelogram fifteen months after operation.

time in 1931. The diagrammatic sketch (fig. 5) of the operation, which I had prepared for Mr. Ainsworth-Davis's section in Maingot's Postgraduate Surgery, Vol. II (London, 1936) is self-explanatory, but I would call attention to a few points. The splinting catheter (12 F rubber whistle-tip) is firmly sutured into the divided ureter. The ureter is held in position at the lower angle of the new pelvis by the first suture joining the cut edges of the pelvis. Both the splinting catheter and the
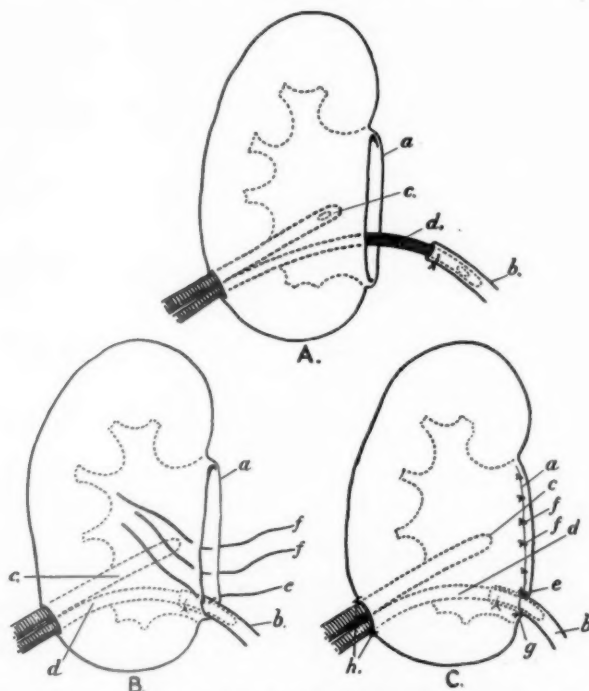
FIG. 5.—Excision of pelvis and implantation of ureter. "Maingot's Postgraduate Surgery," p. 2843. (From Medical Publications Ltd.).

A. *a* = Cut edge of pelvis.   *b* = Ureter.   *c* = 16 F catheter in pelvis.   *d* = 12 F catheter sutured into ureter.

B. *a*, *b*, *c*, *d*, as in A.   *e* = First suture attaching ureter to lower angle of pelvis. *ff* = Sutures through cut edge of pelvis (not tied).

C. *a*, *b*, *c*, *d*, as in A.   *e* = First suture attaching ureter to lower angle of pelvis (tied). *ff* = Sutures through the edges of the pelvis (tied). *g* = Extra suture attaching ureter to new pelvis. *h* = Sutures attaching each catheter separately to renal capsule.

large catheter for drainage (16 F rubber whistle-tip) are attached to the capsule of the kidney by sutures, and also to the skin at their exit from the wound.

I am showing the results of two operations. One is good. The patient has had no symptoms since the operation, the urine is free from infection and the renal function is normal (figs. 6 and 7). The other is unsatisfactory. The patient is well and free from symptoms three years after operation but the pyelogram is still grossly abnormal.

Fig 6.—Patient B. R.   Pre-operative   Fig. 7.—Patient B. R.   Pyelogram ten
          pyelogram.   months after operation.

RESULTS OF EXCISION OF PELVIS AND RE-IMPLANTATION OF URETER
(VON LICHTENBERG) : 10 CASES

Free from symptoms (6 cases) :
    Pyelogram satisfactory   ..   ..   2 cases (6½ : 3½)
    Pyelogram abnormal ..   ..   ..   4 cases (5¾ : 3 : 1¾ : 1¾)
Untraced (1 case)
    Satisfactory pyelogram (1¾) : symptomless (1¾)
Failures (3 cases) :
    No change in symptoms or pyelogram   ..   1 case (4)
    Free from symptoms : bilateral calculi   ..   1 case (6½)
    Secondary nephrectomy   ..   ..   1 case

Conservative procedure and temporary nephrostomy.—The third type of operation
I have performed is to combine some conservative procedure with temporary nephro-
stomy by the von Lichtenberg technique.   The diagram shows how this method of
drainage is carried out (fig. 8).   The catheter used is a 16 F rubber whistle-tip
catheter, which is introduced by passing a forceps into the pelvis and out through
the lower calyx, the catheter being then drawn back into the pelvis and sutured to
the capsule of the kidney and finally also to the skin.   The procedures which have
been carried out in conjunction with temporary nephrostomy are as follows :—

Dissection of fibrous bands   ..   ..   3 cases
Dissection of fibrous bands and dilatation of uretero-pelvic junction ..   2 cases
Ligature of vessels   ..   ..   1 case
Ligature of vessels and dissection of bands   ..   ..   ..   1 case
Ligature of vessels and dilatation of uretero-pelvic junction   ..   1 case

As illustrations I have selected a case which shows a normal pyelogram five and a
half years after operation (dissection of bands and temporary nephrostomy), and one
which shows an unchanged pyelogram three years after operation (dissection of
bands, dilatation of uretero-pelvic junction and temporary nephrostomy), although
the patient is well and free from symptoms and there is no infection.

RESULTS OF CONSERVATIVE PROCEDURE AND TEMPORARY NEPHROSTOMY
(8 CASES).

Free from symptoms (7 cases) :
     Pyelogram perfect   ..   ..   ..   5 cases ($5\frac{1}{2}$: 4 : 3 : 3 : $3\frac{1}{2}$)
     Pyelogram abnormal   ..   ..   ..   2 cases (6 : 2)
Untraced (1 case) :
     Pyelogram abnormal (fifty-third day) : symptomless (1)

Re-implantation of ureter into bladder.—I have used Sampson's technique which I found in Voelcker and Wossidlo's " Urologische Operationslehre " (Leipzig, 1921), in two cases. In one the result is good (figs. 9 and 10) and in the other the
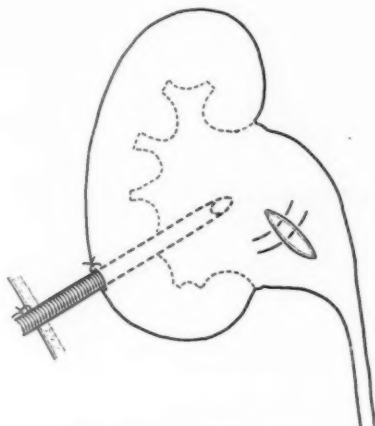
FIG. 8.—Temporary nephrostomy.

dilatation of the ureter and pelvis persists, although the patient has had no renal pain and no attacks of fever since the operation.

Two instructive late results.—Before making a general summary of my results I should like to report two cases in which chance has enabled me to do pyelograms many years after conservative operations.

I am indebted to Sir James Walton for the original notes of the first patient. He operated on her in 1919, when she was 14 years old. There was a hydronephrosis with an abnormal lower pole vessel. He divided the vessel and did a type of plastic operation resembling Finney's gastroduodenostomy. The patient remained well afterwards for fourteen years. She then again began to have pain and after nine months I saw her and carried out an examination of her urinary tract. The pyelogram of 1934 shows a more advanced condition than the 1919 pyelogram, and the kidney which I removed shows little or no sign of the old plastic operation (fig. 11).

The other patient was operated on by the late Mr. Frank Kidd in March 1921. The operation performed was division of lower pole vessels, dissection of bands and a plastic procedure. I did an instrumental pyelogram in September 1934 and an excretion pyelogram in December 1938. Both are normal, thirteen and a half and eighteen and three-quarter years respectively after the operation. It is my impression that this exceptional result is due to the division of the vessels and the dissection of bands, and not to the plastic procedure.

FIG. 9.—Patient S. R. Pre-operative pyelogram.

FIG. 10.—Patient S. R. Pyelogram four and three-quarter years after operation.
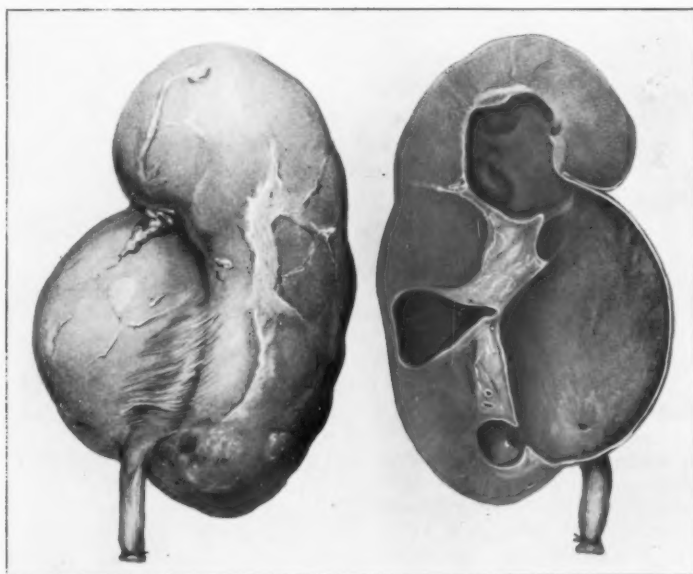
FIG. 11.—Patient E. G. Kidney removed in 1934.

Summary of Results

I am well satisfied with the results of ligaturing and dividing abnormal vessels and I shall continue to perform this operation whenever it appears to me to be certain that the vessels are the cause of the obstruction.

Excision of the pelvis and re-implantation of the ureter give good results in certain cases, but I am unfortunately unable to say in which cases the result will be perfect and in which it will be satisfactory to the patient, but not necessarily to the surgeon. It is these cases, in which the patient is free from symptoms, perhaps even with some slight improvement of renal function, while the pyelogram remains grossly abnormal, which cause me most anxiety. Did I do right not to perform a nephrectomy ? Is not the incompletely emptying kidney, although giving no obvious indication of its defects, still a source of danger to the patient from its increased susceptibility to infection and stone formation ? Considerations such as these must be always before us at the time of operation or otherwise we may be persuaded to perform a technically pleasing operation to preserve an almost useless kidney : and it is in those cases where the hydronephrosis is large and the kidney of little worth that it is easiest to perform the operation, another factor which may turn the scales in favour of a conservative operation when it is already too late.

A minor conservative procedure combined with temporary nephrostomy works well and I should like to draw attention particularly to those three cases in which dilatation of the uretero-pelvic junction was carried out. In all of them there was a narrow junction and the urine contained in the pelvis could not be emptied into the ureter by pressure. If the dilatation had not been done it would have been necessary to divide the ureter and re-implant it, and in each case the simpler operation performed gave a good result.

My present intention is to continue to perform conservative operations of all the types I have described, but I must confess that if my work shows any general tendency at all it is a tendency to perform more nephrectomies and fewer conservative operations.

Note.—In the tables showing my results the figures in brackets refer to the time in years which has elapsed since the operation was done.

The two untraced patients were untraced in May 1939, and the figures refer to the last occasion on which I saw them or carried out an examination.

Mr. Hamilton Bailey : *Plastic operations for hydronephrosis.*—In November 1935 I brought before this Society two cases of hydro-pyonephrosis treated by resection of the renal pelvis, end-to-end anastomosis over a ureteric catheter, and nephrostomy. Major plastic operations for hydronephrosis were certainly not in vogue in this country at that time. Even to-day the majority of urologists view these procedures with scepticism.

James C. Sargent, in the *Journal of Urology*, 1937, says " the feeling is quite general that plastic repair of unilateral hydronephrosis is a futile and foolish procedure if there is loss of function, if there is considerable distension of the renal pelvis, and, particularly, if infection has occurred ". Cabot, a little earlier, expressed abundant scepticism regarding ultimate results. He stated that he felt the repair breaks down and results in infection. Professor Marion, a few years ago, stated that all kinds of plastic operations for hydronephrosis were unsatisfactory. I gather from his more recent writings he is changing his views. Our President ended his Ramon Gutierrez lecture by stating that plastic operation for hydronephrosis gives relief for a time only, and where there is no contra-indication that patient is indeed fortunate when nephrectomy is the procedure of choice. Perhaps the most startling condemnation is that of Frank Hinman, who says that in the case of unilateral hydronephrosis, even if the obstruction is removed, plastic

operations are doomed to failure, for the opposite kidney, having undergone anatomical hypertrophy, will not release its function.

Without wearying you with further quotations from the literature, I think we may take it that the value of major plastic procedures on advanced cases of hydro-nephrosis, particularly when infection has occurred, are unpopular. One of the main reasons for this unpopularity is that no bulk of evidence of successful late results has been brought before this or any other Society.

Following a paper of mine some two and a half years ago, Alex Roche replied in the correspondence column of the *British Medical Journal :* " I note Mr. Bailey's
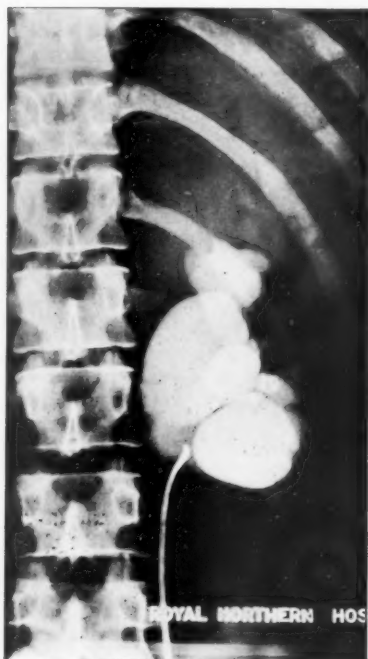
FIG. 1.—Eileen P., aged 20.　28.2.36.
Pyelogram showing large hydronephrosis.
While awaiting admission an acute exacer-
bation occurred and she was admitted as
an emergency and operation performed.

FIG. 2.—Eileen P.　Three and three-quarter years
later.　The patient has been in perfect health and is
at work as a telephone operator.

pyelograms in your issue of October 3 show a large pelvis before operation and a small one ' some weeks after operation '.　Naturally, soon after operation the pelvis will be small, as three-quarters of it have been removed, but will it still be small five or ten years after the operation ? "　I still cannot answer this riddle, but I can to-day show pyelograms of the renal pelves of the cases in question three and three-quarter years after the resection (figs. 1 and 2).

During these three and three-quarter years I have treated 64 cases of hydro-nephrosis and pyonephrosis.　Some of these have been too advanced to consider

any reconstructive operation. Others have been amenable to relatively minor plastic procedures such as division of small aberrant vessels, renal sympathectomy, and nephropexy. In 30 cases the same major plastic procedure was undertaken. Briefly it consisted of drastic resection of the renal pelvis followed by end-to-end nephro-ureteric anastomosis. The steps of the operation will be made clear by figs. 3, 4, 5, and 6.

I have made a great effort to follow-up all the cases with adequate pyelographic studies and renal function tests. This work has been far from easy, for it is difficult to persuade a patient who is perfectly well to undergo cystoscopy, or even excretory pyelography. Some of the patients were at work, and while willing to co-operate,

FIG. 3.—The obstruction at the pelvi-ureteric junction is identified and the ureter is severed from the hydronephrotic sac.

FIG. 4. — The hydronephrotic renal pelvis is resected so as to drastically reduce its capacity.

could only attend when the X-ray department was closed. It thus comes about that what would seemingly be a routine investigation became a labour of considerable magnitude.

I will concentrate my remarks on 26 cases operated upon between August 28, 1935, and December 31, 1939.

Number of cases = 26

Perfectly well. Cystoscopy; indigo test; pyelography; bacteriology	14
In full work. Renal function poor	2
Perfectly well. Refused cystoscopy, but intravenous pyelography performed ..	4
In full work. Seen, but will not attend for pyelography	2
Good renal function. Symptom-free. Kidney contains three small calculi ..	1
Renal fistula (later nephrectomy)	1

Same operation for cast calculus of the renal pelvis

Number of cases	2
Stone returned ; nephrectomy ..	1

Some of the best end-results have been those which looked most unpromising, i.e. those with a very large hydronephrotic sac with infection. While every effort

should be made to clear up infection before the operation is undertaken, I do not look upon infection as a contra-indication ; indeed, in two of my patients, who are now in perfect health, a frank pyonephrosis was present.

The success of the operation depends on a very exact technique. To Professor von Lichtenberg we owe a great deal in this branch of surgery. I am compelled to state, however, that I consider the von Lichtenberg operation to be far less reliable than that illustrated in figs. 3 to 6. By employing the von Lichtenberg technique the extreme inferior part of the pelvis is unlikely to drain completely ; there must always be a little pool which invites infection.

In addition to cases of hydronephrosis I have employed the same operation in two examples of a complete cast calculus of the renal pelvis, which would otherwise
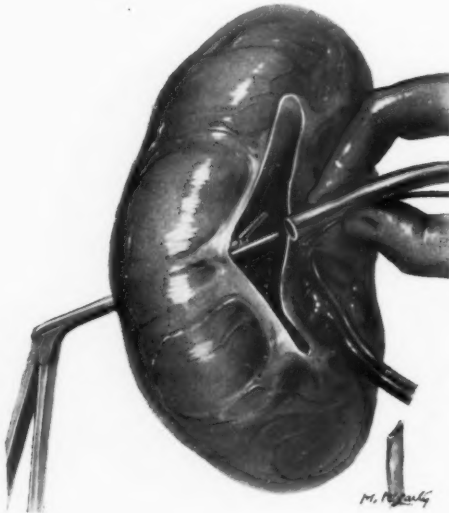
FIG. 5.   FIG. 6.

FIG. 5.—Temporary nephrostomy is performed.

FIG. 6.—The cut edges of the base of the renal pelvis are united, and an end-to-end anastomosis is performed between the ureter and the lowest extremity of the renal pelvis. A ureteric catheter supports the anastomosis, and this is brought out through the nephrostomy opening.

call for nephrectomy. In one of the cases the stone recurred, and nephrectomy had to be undertaken later. In the other case, which is of comparatively recent origin, the measure appears to have been successful.

As a result of this investigation I feel that those who set their faces steadfastly against these reconstructive operations will at least admit that plastic operations on the renal pelvis are not necessarily doomed to failure. What is proved up to the hilt is that if in a case of unilateral hydronephrosis the obstruction is removed, the opposite kidney having undergone anatomical hypertrophy *does* release its function.

Further illustrations of cases : *see* figs. 7 to 10.

FIG. 8.—Elizabeth S. Retrograde pyelogram three years later. The function of this kidney is perfect and the patient has had no symptoms.

FIG. 7.—Elizabeth S., aged 39. 14.5.36. Gave a typical history of recurrent attacks of renal colic with infection.

FIG. 9.—Annie H., aged 50. 18.11.37. Three years history of right-sided abdominal pain and vomiting. The extraordinary appearance of the lower end of pyelogram was proved to be due to a large aberrant renal artery constricting the pelvi-ureteric junction. The artery was preserved.

FIG. 10.—Annie H. Two and a half years later. The patient has remained well. The urine and renal function tests are normal.

Since reading this paper I have had three consecutive failures—renal fistula developing and proceeding. In these three cases I altered the technique of the operation slightly and adopted Heitz-Boyer's suggestion of a nephrostomy through the lower pole of the kidney. That such a slight modification should make such a difference between success and failure goes to show that the outcome and the future of these operations depend on a meticulous technique.

Mr. W. E. Underwood: In cases of idiopathic or so-called congenital hydronephrosis, though abnormal vessels and other extraneous mechanical factors play a part in the production of the condition, it is essentially a secondary part, the end-results being entirely dependent upon an initial enlargement of the renal pelvis which, by its progressive dilatation, brings these extra factors into play : alone they would do nothing in almost 100% of the cases. There are, however, cases where this enlargement is seen alone, indicating that a hydronephrosis is able to become progressively enlarged without the superadded mechanical factors being brought into play ; such cases may even progress to a stage with complete destruction of the renal cortex. Fig. 1 shows the stages of a hydronephrosis, and it is those cases

LIFE HISTORY OF AN IDIOPATHIC HYDRONEPHROSIS

EARLY ENLARGEMENT OF THE RENAL
PELVIS—WITHOUT SYMPTOMS—
DISCOVERED BY PYELOGRAPHY.

ENLARGED RENAL PELVIS WITH SYMPTOMS, BUT WHERE THE ABNORMAL VESSELS ETC. HAVE NOT YET COME INTO PLAY.	ENLARGED RENAL PELVIS WITH SYMPTOMS—PAIN, INFECTION, ETC.
Ditto—the abnormal vessels have now come into play and are causing gross mechanical obstruction.	Early mechanical obstruction at the pelvi-ureteral junction due to aggregation of lymphoid tissue—progressing to early fibrosis and resulting in a stricture.
Renal cortex destroyed.	Renal cortex destroyed.
HYDRONEPHROSIS OF IDIOPATHIC TYPE *WITH* SECONDARY MECHANICAL FACTORS.	IDIOPATHIC HYDRONEPHROSIS ALONE.

Fig 1.

in bold type which I wish to consider ; the others have been adequately dealt with by other speakers. The problem associated with these cases is aptly summed up by Mr. Winsbury-White in his Hunterian Lecture, 1924, in which he said : " There is still widespread diversity of opinion as to the primary ætiological factor in the pelvic type of the disease."

My ideal of conservatism has been to deal with the cases in their earliest phase in the hope of preventing the pelvis going on to those later stages where pyeloplasty is required, or at least to bring about improvement over a considerable period of time, so that pyeloplasty is still retained as a valuable second string should it be later indicated.

Investigation of the pathology of hydronephrosis suggests some deficiency of the neuromuscular mechanisms, so that the stimulus of a full renal pelvis is no longer transformed into adequate co-ordinated movements of emptying; this is in my opinion largely due to a deficiency of nerve endings, which of course cannot be replaced. The question arises as to whether it is in many ways better to have the pelvis and ureter emptying automatically by their own intrinsic co-ordinating mechanism rather than controlled incorrectly by an extrinsic mechanism, provided of course that the resulting emptying is efficient. Thus arises the theory of treatment of hydronephrosis by peri-arterial sympathectomy, but it must be emphasized that the aim is not to relieve pain alone, for this is extremely dangerous unless evidence of improvement in the condition is at the same time shown by decrease in size of the renal pelvis, and improvement in emptying time; in other words, the stagnant renal pelvis or reservoir has to be changed into a flowing channel, or at least into a
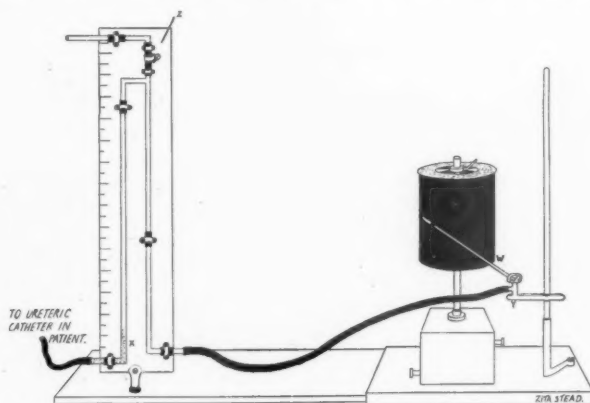
Fig. 2.—The water manometer (x) on the left is open at the top but can be closed by a tap (z); when open the pressure in the renal pelvis is read while contractions may be observed from movement of the meniscus; when closed the meniscus movements are recorded on the drum (on the right). The value of the tap is that it releases undue pressure in the tambour which would tend to damp down the amplitude of the recorded contractions.

smaller reservoir which empties itself completely from time to time rather than retaining residual urine, the sequelæ of which are only too well known.

Selection of cases : criteria by which suitable cases are recognized.—(1) Cases with recurrent attacks of renal colic, and those cases where a urinary infection was the first symptom, the investigation of which led to the diagnosis.

(2) Enlargement of the renal pelvis, especially in those cases where there is no superadded mechanical obstruction due to abnormal vessels or changes at the pelvi-ureteral junction. Where there is doubt these superadded factors can be dealt with at operation by whatever means is then indicated.

(3) It is essential that the pelvis must be capable of contracting down from its dilated shape; if this be not possible, sympathectomy is unsuitable, and other forms of treatment become necessary.

A method of testing those cases suitable for treatment.—Using this form of apparatus (fig. 2), with the ureteric catheter lying in situ connected to the water manometer (X), the pressure inside the renal pelvis can be noted at a glance, while contractions of the renal pelvis may be observed by movements of the meniscus. These range from

½ to 2 cm. of water in normal circumstances. A graphic record of the movements may be made by closing the tap (Z) so that the waves of contraction are transmitted to the tambour (Y) and recorded on the drum (W). The value of the tap is important, otherwise the recorded waves would be unnecessarily damped by the rise of pressure in this column of air when the water in the manometer rose. If there is doubt as to whether a case is suitable for sympathectomy, the effect of a spinal anæsthetic is often of value by showing that the pelvis is able to contract regularly, as shown in fig. 3.

Assessment of end-results.—A similar method of examination is of value by showing that the previously inert renal pelvis is now not only able to contract (because it could do so before treatment), but it can now do so regularly of its own free will and accord, a rhythmic *emptying* of the renal pelvis being the result. Fig. 3 shows the case you have previously seen tested by the spinal anæsthetic, after treatment by peri-renal sympathectomy.
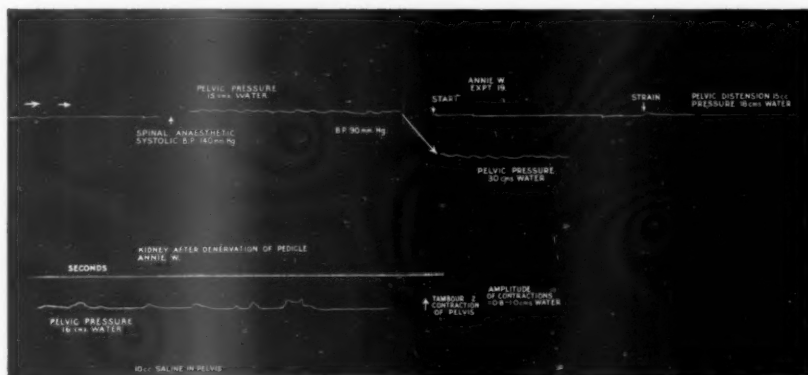
Fig. 3.—The inert renal pelvis is recorded as a straight line in the upper tracing, the effect of the spinal anæsthetic is clearly seen by the regular contractions of the pelvis recorded throughout the remainder of the tracing.

The spinal anæsthetic reached the level of D. 4.

The lower tracing shows the same renal pelvis after a perirenal sympathectomy; the pelvis contracting regularly and thus emptying itself of all residual urine *of its own accord.* (The decrease in size of the pelvis as seen by a pyelogram is well marked in this case.)

Mr. Riches mentioned among his criteria of success abolition of pain, radiological improvement, and functional improvement. The assessment of pain and radiological improvement is relatively simple, and these methods of producing a graphic record of the end-results of sympathectomy may be of interest to you in assessing functional improvement. The two pyelograms (figs. 4 and 5) are from the case of a man, aged 22, who for five years had had recurrent attacks of left renal colic, lasting three days, recently at intervals of a month, and completely incapacitating him. The first, fig. 4, shows the intravenous pyelogram and a pyelometric tracing. This case was treated by sympathectomy of the renal pedicle, and fig. 5 shows the end-result : a smaller renal pelvis, suggesting less stagnation, and the regular contractions indicating that the urine is being pumped along and so avoiding stasis. This man has remained perfectly well for two and a half years, has had no further attacks of pain since the operation : he is now serving as a pilot officer.

Basing treatment on the theory that there may be deficient innervation of the renal pelvis by parasympathetic impulses rather than necessarily over-action of the

FIG. 4.—The intravenous pyelogram of a patient who had had recurrent attacks of renal colic over a period of years. The pyelometric tracing below shows an inert renal pelvis even with an intrarenal pressure varying between 16 and 25 cm. of water. The effect of compression of the abdomen is recorded on the tracing to verify that the absence of contractions is due to the inert pelvis and NOT to any mechanical block or other error in the recording apparatus.

sympathetic, it may be of value to leave, if possible, fibres carrying parasympathetic impulses to the kidney, for they must of necessity be divided in carrying out a sympathectomy. In view of this, and of the technical operative difficulties often associated with an arterial sympathectomy, especially in bilateral cases, the value

of a splanchnic neurectomy is worth considering. Should subsequent pyeloplasty be required, *the pelvis may be explored in its natural state free from the peripelvic fibrosis which follows any renal exploration.*

This operation undoubtedly divides all sympathetic fibres passing to the kidney, leaving behind parasympathetic fibres coming, as we think, via the vagus : the

Fig. 5.—The same case recorded in fig. 4 after a sympathectomy operation. The decrease in size of the renal pelvis is well shown while the tracing also proves that active contractions are now taking place which will bring about more complete emptying of the pelvis with resulting absence of stasis.

operation is not extensive, and seeing that there are only nerve trunks to be divided rather than individual fibres, one can be more certain that all fibres which one sets out to divide are actually divided. The pros and cons of the various type of technique in carrying out this operation are outside the scope of the discussion, but in

view of its bearing on end-results I bring these observations before you in case they should be of interest, indicating in one way a less complete but perhaps actually more efficient operation than peri-arterial sympathectomy.
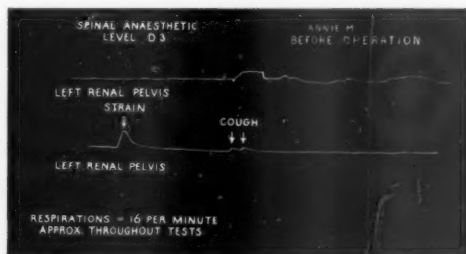
FIG. 6.—The lower tracing shows the condition of the renal pelvis before treatment. Here the effect of straining or coughing has been used to demonstrate the absence of any mechanical defect before testing the effect of a spinal anæsthetic which is recorded in the upper tracing, this demonstrating the suitability of the case for treatment by some form of denervation operation.

FIG. 7.—Immediate effect of a splanchnic neurectomy, regular contractions of the pelvis resulting.

FIG. 8.—The final end-result some time later. Regular rhythmic contractions suggesting adequate emptying of the renal pelvis.

Fig. 6 shows a tracing of the hydronephrosis before operation, the result of the spinal anæsthetic indicating that the case was suitable for some form of denervation operation.

Fig. 7 shows a tracing of the renal pelvis three weeks after the splanchnic neurectomy, and fig. 8 shows the last tracing taken recently.

The President : I wish to emphasize two points about hydronephrosis and conservative operations :—

(1) Apart from the local symptoms there is a definite toxæmia from a hydronephrosis, even when it is uninfected.

(2) If the minor calyces are already expanded to any extent before the plastic operation is undertaken, they will continue in this state, and will harbour pools of residual and infected urine subsequently; no further obstruction is added as a result of a plastic operation.

Because of the latter fact nephrectomy stands supreme as the remedy for advanced hydronephrosis. But it is where the disease is bilateral or where it is well developed on one side and shows a tendency to it on the other, that the conservative procedures are necessary.

I have given a fair trial to two types of conservative operations for hydronephrosis, and I will put some of my data before you. First with regard to the von Lichtenberg

Fig. 1.

operation, I carried this out on ten cases then abandoned it because I was dissatisfied with the results. I then employed a much simpler procedure which I will describe later.

Professor von Lichtenberg performed a plastic operation for hydronephrosis on March 25, 1931, at St. Paul's Hospital. The patient was a single woman aged 22 who had complained of pain in the right side for nine years. The urine contained a few pus cells only and *B. coli*. The pyelograms showed what appeared to be a very suitable case for a plastic operation, a moderately developed pelvic hydronephrosis on the right side (fig. 1). As I provided the case for the operation I have had an opportunity of following it up later.

There were two fairly quick and dramatic results of the operation, one was the immediate disappearance of the pain in the right side ; the other was that she ceased to menstruate, and when last seen five years after the operation, this function had not yet returned, and although she had then been married for three years no pregnancy had resulted. She had remained completely free from her pain, but the urine was

hazy with pus from a *B. coli* infection, and the best intravenous urogram which could be obtained was one which showed in the right renal region, two small areas of opacity each the size of a shilling forty-five minutes after the injection (fig. 2).

It is a deceptive and interesting fact that disappearance of the pain is a common result of a plastic operation, although the hydronephrosis can be shown to be still present.

The same facts are regularly noted after division of a blood-vessel which is obstructing the ureter. In the latter type of case one can well understand how the division of the blood-vessel improves the drainage ; but it cannot cure the hydronephrosis, as the original cause of the dilatation, of which the vascular obstruction is but a complication, is still present. This conclusion is in accordance with the facts which I brought forward as long ago as 1924 (*Brit. J. Surg.*, 1925, **13**, 247–281).

Fig. 2.

It was my experience with the von Lichtenberg operation that almost invariably there was a prolonged convalescence with an oscillating temperature. I came to the conclusion that the pyrexia was due to an infection wandering slowly through the renal substance. The result of this must certainly be a considerable destruction of renal tissue, and probably explains why in all my cases I found renal function strikingly less than before operation was carried out.

The pyelograms in the next case, a woman aged 33, upon whom I carried out the von Lichtenberg operation have a bearing on this point (figs. 3 and 4) for a few months later I was quite unable to get an excretion pyelogram on the affected side, and the instrumental picture shows dilatation of all the calyces, and an appearance in the lower pole suggesting a destruction of tissue. The patient had a three months' convalescence resulting from prolonged pyrexia and a loin fistula. Three years later an attempt at an instrumental pyelogram showed a complete obstruction at the pelvi-ureteric junction. At this stage there was no pain, nor had there been since the operation ; the left kidney was palpable but not tender and the urine was hazy with pus and *B. coli*.

In another case, a girl aged 8, with bilateral congenital hydronephrosis and stone on left side, I operated on the left side only. Six months later the hydronephrosis had returned, the renal function was much reduced, and the pelvi-ureteric junction was obstructed and it was impossible to pass my ureteric catheter through it (figs. 5 and 6). Later I carried out a nephrostomy on the left side with a resulting great improvement in her health ; to-day, at the age of 13. she is well and is quite comfortable with her tube. There has been no occasion to intervene on the right side as there is no evidence of infection in this kidney and no pain.

The next case was a man aged 20 complaining of attacks of right-sided pain for two years. The intravenous pyelogram showed an early hydronephrosis on the

FIG. 3.   FIG. 4.

right side (fig. 7), and as the pelvis on the left side tended to be somewhat wider than normal, I thought it would be safer to do a conservative operation on the right kidney. I carried out the von Lichtenberg operation, and the pain disappeared for nearly five years, when it returned. During this period I saw the patient at intervals of seven months, twenty-two months, and five years, when excretion pyelograms were taken. The urine which had been clear before the operation was hazy with pus and *B. coli* on all these occasions. In the first pyelogram (at seven months) there was evidence of both diminished function and increased dilatation (fig. 8) ; but in the second one (twenty-two months, fig. 9) there was improvement in both these directions and the dilatation was now about the same as before operation.

FIG. 5.

FIG. 6.

The final intravenous pyelogram (five years, fig. 10) showed still further dilatation, and a return of delayed function. By this time his pain had returned and he complained also that he did not feel well and got tired easily. It was quite a regular
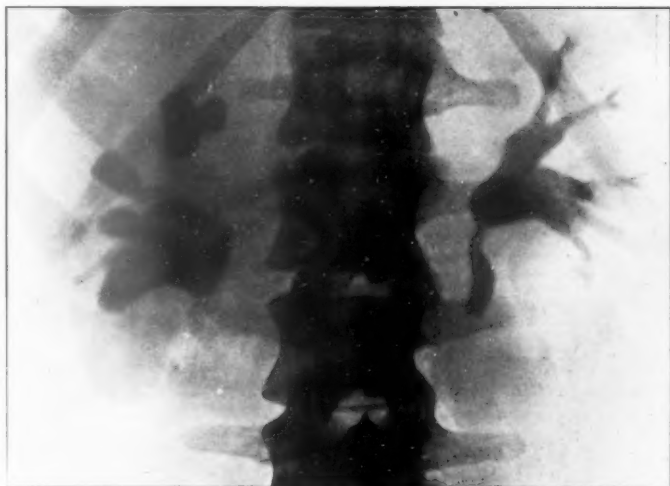
FIG. 7.

FIG. 8.

feature post-operatively to note an absence of pain although hydronephrosis was still present. I performed nephrectomy, after which the patient soon lost his pallor and tiredness ; and was conscious of an improvement in his general health.

On examining the kidney after removal it was with the greatest difficulty that I could get a fine probe up the ureter into the pelvis. The ureter was obviously inadequate at the site of the anastomosis. I may remind you that it was part of the

Fig. 9.

Fig. 10.

technique of the von Lichtenberg operation to leave a small projection of the ureter into the pelvis when the implantation of this structure was made. It was therefore not surprising to find that the ureter opened into the pelvis on a small hillock. There

is by no means a marked degree of dilatation of the pelvis and calyces, and it is instructive to note, nevertheless, that it was enough to be associated with considerable ill-health.

The next case looked as though there was some prospect of success but for the development of stones in the kidney subsequently to the plastic operation. The patient was a woman aged 28 who had a stone in the left kidney in association with an early pelvic dilatation, which feature was also to be noted on the right side. It was this latter fact which tempted me to do a plastic operation on the left after removing the stone.

The patient had no symptoms and kept in perfect health for five years after the operation, when after two attacks of left-sided renal colic she passed two small stones. Another attack of left-sided colic and another stone was passed in May 1939. On examining the patient at this stage the urine was hazy with pus. A plain X-ray showed a collection of small stones in the left kidney and the urograms showed that there was a definite further advanced left hydronephrosis than there had been previously to operation. But the patient was apparently in excellent health and felt well. In due course I removed the left kidney with a satisfactory result.

I now carry out a simple plastic operation instead of the von Lichtenberg procedure. It involves a resection of a portion of the pelvis so as to leave this reduced in size and so shaped as to give good dependent drainage. The required amount of pelvic wall is excised along the lower border, and after dilatation of the pelvi-ureteric junction, the pelvis is restored by interrupted catgut, Lembert sutures, and the wound closed with a rubber drain down to the suture line. Care should always be taken in incising the pelvis to see that the incision keeps well short of the pelvi-ureteric junction because of the danger of obstruction at this point from subsequent scar tissue. At the same time I do not take the excision nearer than half an inch to the renal hilum to avoid unnecessary difficulty in placing the sutures.

The following three cases were dealt with by this method, and represent respectively periods of one, two and six years after operation. The cases representing the one and six year periods show continued good function and no increase in dilatation, while the case representing the two-year period, although it shows function to be as good as ever, seems to indicate a very slight tendency to further dilatation. It is very doubtful if any plastic procedure will ever cure a hydronephrosis as it makes no attempt to treat the original cause, of which we seem to be as completely in the dark as ever !

CASE OF SIMPLE PLASTIC OPERATION WITH RESULT ONE YEAR LATER

E. L., female, aged 56.
Complained of pain in right loin. Excretion pyelogram (fig. 11) showed a moderate degree of right pelvic hydronephrosis.
17.6.38 : Simple plastic operation for hydronephrosis.
8.9.38 : No further pain. Excretion pyelogram showed good function and no evidence of hydronephrosis (fig. 12).
18.5.39 : No return of pain. Excretion pyelogram showed function not quite so good, but no tendency to return of hydronephrosis (fig. 13).

CASE OF SIMPLE PLASTIC OPERATION WITH RESULT TWO YEARS LATER

E. E., female, aged 25.
Complained of blood in water and pain in left loin. No frequency.
12.8.36 : Excretion pyelogram showed a well-developed pelvic hydronephrosis on left side. Three months later excretion pyelogram showed no hydronephrosis.
February 1937 : Simple plastic operation on left kidney.
12.5.39 : Urine : *B. coli.* No pain or blood. Excretion pyelogram showed good function but slight tendency to a return of the pelvic dilatation.

FIG. 11.—E. L.

FIG. 12.—E. L.

CASE OF SIMPLE PLASTIC OPERATION WITH RESULT SIX YEARS LATER

J. T., female, aged 51.

Complained of attacks of pain in left side. Urine: No pus, a few staphylococci. Excretion pyelograms showed early hydronephrosis on left side (fig. 14).
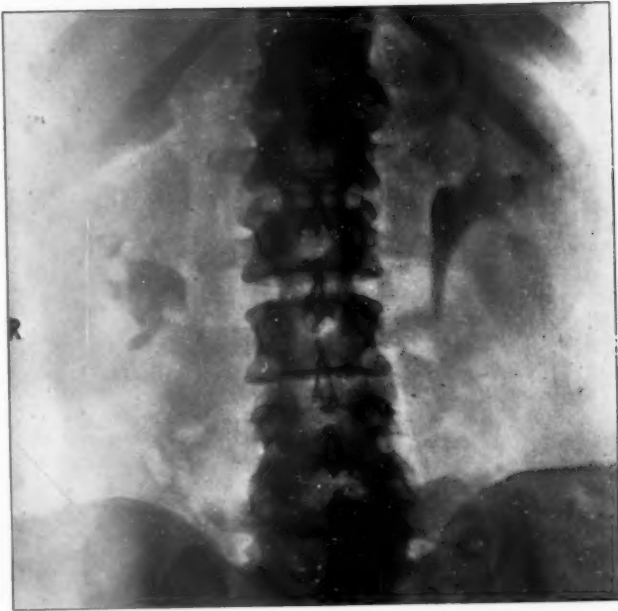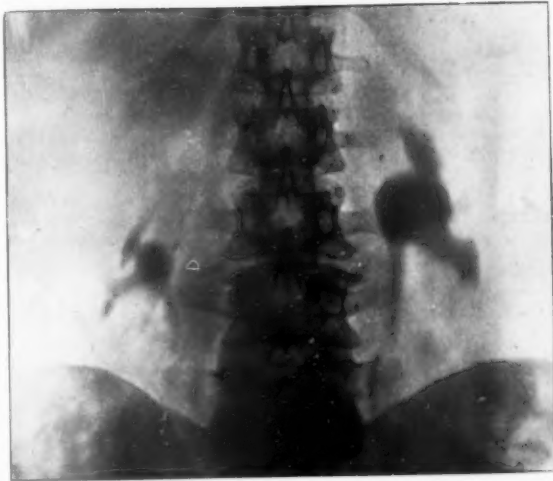
Fig. 13.—E. L.

Fig. 14.—J. T.

5.1.33 : Simple plastic operation.

A few months later.   Excretion urogram showed good function and no dilatation.

15.5.39 : No complaint of pain.   Urine : *B. coli*, no pus.   Excretion pyelograms showed no return of tendency to dilatation on left side, but some reduction of functional activity, and a tendency to dilatation on the opposite side (fig. 15).

Fig. 15.—J. T.

From these observations I have concluded that the simple plastic procedures are better than those which divide the ureter, but that while the original cause of the hydronephrosis remains untreated, we still have to cope with the tendency for the disease to be bilateral and even to return on the side which has been operated upon.

In reply **Mr. Riches** said that he too had experienced difficulty in getting patients to attend for a repetition of these elaborate investigations but considered them essential for a true assessment of results.   He thought that Mr. Underwood and Mr. Oldham had approached nearest to the root of the problem under discussion and was particularly impressed and encouraged by the late results of sympathectomy shown by Mr. Oldham.   He considered that the ætiology of the bilateral cases was the same as that of the unilateral ones in the absence of mechanical obstruction, namely a neuromuscular defect.   All the cases described had been fully investigated and the presence of urethral stricture ruled out.

JOINT DISCUSSION No. 8

Section of Orthopædics and Section of Neurology

Chairman—R. Ollerenshaw, F.R.C.S.

(President of the Section of Orthopædics)

[*April* 4, 1939]

DISCUSSION ON PROLAPSED INTERVERTEBRAL DISCS

Protruded Intervertebral Disc (Fibrocartilage)

By J. Grafton Love, M.D. (Mayo Clinic)

Historical

When a search of the literature is made to discover the original description of a pathological condition, one frequently goes back to relatively early days of medical writings. Oftentimes, it is found that the great Virchow made some observations on the subject. In the literature on intervertebral discs in 1857 he referred to extrusion of cartilage from an intervertebral disc, caused by trauma. However, it was not until March 1911 that Goldthwait, after an unfortunate complication had arisen following manipulation of the spinal column, directed the attention of the medical profession to the importance of intraspinal extrusion of disc tissue with compression of the cauda equina. In July of that same year there appeared in the *Glasgow Medical Journal* an article by Middleton and Teacher in which they described a case of injury of the spinal cord caused by rupture of an intervertebral disc during muscular effort. Their patient died and the results of a post-mortem examination are recorded. They were able experimentally to reproduce the lesion in another spinal column. In 1922, Dr. Adson of the Mayo Clinic removed a protrusion of the 4th lumbar disc from the spinal canal of a dentist suffering from intractable sciatic pain. That patient, incidentally, has been well since operation without recurrence of his former trouble. In the same year, Dr. Adson [2] removed a portion of a protruded cervical disc, a report of which he included in a paper on tumours of the spinal cord published in July 1925.

In 1928, Stookey of New York reported a series of seven cases of protruded cervical intervertebral discs. Dandy of Baltimore in 1929 reported two cases of paraplegia caused by protrusions of lumbar discs and discussed the rôle of trauma in the causation of those particular protrusions. Mixter and Barr of Boston in 1934 reported a series of cases and emphasized the importance of the use of radiopaque oil as a contrast medium within the subarachnoid space in the detection of these lesions.

In August 1936 I [14] gave a preliminary report on the subject before our weekly Clinic Staff Meeting and introduced the title, " Protrusions of the Intervertebral Disc (Fibrocartilage) ". Since that report, several papers dealing with this condition have been written and published by members of the Clinic Staff [15, 17, 18, 19, 21]. To-day in the United States the condition called " protruded intervertebral disc " is

recognized as a definite anatomical and pathological condition, and most neuro-surgeons to-day have had experience with the lesion. In 1937, Mr. Capener [10] at a meeting of the Section of Orthopædics of this Society, reported a typical case of lumbar disc protrusion with cure following laminectomy.

Anatomy of the Intervertebral Disc

Between each two vertebræ there is a fibrocartilaginous plate or invertebral disc which normally acts as a shock absorber and which, in conjunction with the cerebro-spinal fluid contained within the spinal dura mater and the arachnoid, acts as a protection for the delicate spinal cord and cauda equina. The intervertebral disc normally occupies the space between each two contiguous vertebral bodies and does not project into the spinal canal. Under conditions of normal stress and strain, the disc may bulge slightly beyond its usual confines, but when the spinal column returns to its normal position, the disc likewise assumes its normal relationship. The anterior and posterior longitudinal ligaments support the spinal column and retain the discs. Under circumstances of unusual stress and strain the disc may project abnormally into the spinal canal, with consequent compression of the spinal cord or one or more of the spinal nerve roots.

An intervertebral disc consists of two separate but more or less intimately connected portions : the nucleus pulposus, which is a very resilient semifluid substance situated in the central portion of the disc ; and an outer, circular fibro-elastic structure, the annulus fibrosus. The masses which are productive of symptoms and which are removed with the most gratifying results at the time of laminectomy consist of both elements ; thus I introduced the term " protruded intervertebral disc " as the most satisfactory terminology for the condition because it describes both the structures involved and the condition itself. The condition has been discussed as " herniation of the nucleus pulposus ", " prolapse of the inter-vertebral disc ", " rupture of the intervertebral disc with extrusion of the nucleus pulposus ", and " slipped disc ". Grossly and microscopically, both nuclear and annular material are found in the protrusions removed at operation [9].

Incidence

According to statistics collected by Dr. Henderson, chief of our orthopædic section, we of the neurosurgical section of the Mayo Clinic have performed laminectomy for protruded intervertebral disc during the past three years on about 2% of all patients seen by the orthopædists[1] because of a complaint of low back and/or sciatic pain. At present it is difficult, if not actually impossible, to state with accuracy the incidence of protrusion of intervertebral discs. In spite of our increased diagnostic acumen and the fact that we are constantly on the alert to discover the condition, we undoubtedly are overlooking some cases having but relatively mild symptoms. In a series of 300 proved cases of protruded intervertebral disc, there were 226 males and 74 females with an average age for the series at operation of 40 years.

In 1922, the year in which the condition of protruded intervertebral disc was first detected, Dr. Adson operated on four such patients at the time of laminectomy to relieve spinal cord and nerve root compression. On the other hand, I have operated on four patients in one morning on more than one occasion. Prior to January 1, 1935, only 12[2] patients had been operated on at the Clinic for protrusion of an intervertebral

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[1] All patients with low back and/or sciatic pain receive, in addition to a general physical examination with the usual laboratory tests, an orthopædic examination.

[2] Only 11 cases were reported in the *Journal of Bone and Joint Surgery*, 1937, **19**, 776-804 but a subsequent checking of the records resulted in the discovery of one additional case of protruded intervertebral disc coming to operation prior to January 1, 1935.

disc. This number represented a very small percentage (approximately 2·5%) of the proved intraspinal space-taking lesions. During the year 1938, however, more discs than tumours were removed at laminectomy.

At one of our staff meetings, Dr. Henderson, in discussing the problem of low back and sciatic pain, stated that after a conference with his associates in the orthopædic section he had calculated that he and his associates were called upon to consult approximately 3,000 patients having such pain each year. When an attempt at calculation is made, it is obvious that in spite of the large series of cases of protruded discs which I am privileged to report, the cases encountered actually account for a very small number of the patients whom we at the Clinic see with low back and sciatic pain. It is true that the number of patients operated on has increased from four in 1922 to 217 during 1938 ; but even the 1938 figure does not establish protruded intervertebral disc as the cause of most painful conditions of the lower part of the back and lower extremities [19]. If this condition were the principal cause of such pain, many problems connected therewith in orthopædics, neurology, radiology and neurosurgery could be solved.

Ætiology

From a study of our cases, the important conclusion emerges that a history of trauma frequently precedes the onset of symptoms. It is true that the patient may not submit himself for careful study and operation immediately after the accident or the occurrence of unusual stress or strain to the back, but a history of pain following injury to the spinal column can usually be elicited. In some cases the patient can recall one outstanding injury, whereas in many instances there have been repeated trauma to the back, usually with aggravation or recurrence of pre-existing pain and disability. It is my feeling (and this has been suggested by others also) that the original injury may have weakened the longitudinal spinal ligaments, and possibly the annulus fibrosus, without the occurrence of a true protrusion of the disc. The actual protrusion of the disc substance, then, into the spinal canal occurs at the time of some subsequent injury which may be less severe than the original one. Possibly as a result of the previous injury, there is in addition to the tearing of structures a degenerative process which facilitates the extrusion of fibrocartilaginous fragments at a later time.

In the case of lumbar protrusions, low back pain, which very frequently antedates the onset of sciatic pain even by many years is, I believe, an expression of injury to the posterior longitudinal ligament and probably also to the annulus fibrosus, without true protrusion of the disc. We all are familiar with the patient with "lumbago", a complaint which many of our patients with protruded lumbar discs had had for many years prior to the onset of the intractable sciatic pain for which they sought relief by surgery. That there may be and probably are predisposing factors which play a rôle, I cannot deny.

Occasionally, in eliciting the history of these cases, it is impossible to obtain any knowledge regarding undue stress or strain on the back. Some patients volunteer the information that they were perfectly well until the onset of a head cold, which was followed by pain in the back and down the leg. Whether a metastatic inflammatory process could so weaken a disc as to permit its subsequent protrusion without unusual strain, I am unprepared to say.

What part congenital anomalies, particularly of the bony structure, have to play in this condition is not clear. For instance, it is not unusual to see a protruded lumbar disc in a patient with a sacralized last lumbar vertebra, a lumbarized first sacral vertebra, a spina bifida occulta or a bifid transverse process of the last lumbar vertebra. Likewise, protruded discs have been found in patients with four and with six lumbar vertebræ.

That protrusion of the discs is dependent upon the upright posture, which in many circles has been held to have resulted in our having weak backs, is not true. Dr. Schlotthauer of the Institute of Experimental Medicine of the Mayo Foundation has furnished me with a specimen of a typical disc protrusion which had resulted in a paralysis of the hind legs and the vesical and anal sphincters of a dog. Dr. Schlotthauer, in examining the dog prior to death and autopsy, detected increased tendon reflexes and diminished sensation in the hind legs and he thereupon made a clinical diagnosis of intraspinal tumour.

Pathology

From a study of 100 protruded discs which were removed operatively by the neurosurgeons at the Clinic, Deucher and I were able to distinguish grossly two different types of posterior protrusions of the discs. Although when exposed, the protrusion in situ is seen to be hemispherical or oval in shape, it loses this shape when the involved nerve root is retracted or when the stretched-out posterior longitudinal ligament is incised. In some cases, simple retraction of the involved root permits escape of the entire protrusion which can be lifted from the wound with a forceps. In other cases, the longitudinal ligament is stretched over the top of the protrusion, which cannot be removed until the ligament is incised. The protrusion may consist of a single fragment of variable size (the severity of symptoms is not dependent on the size of the fragment but upon the relationship of the protrusion to the spinal cord or nerve root) or many fragments. The consistency of the fragments varies markedly also from that known as soft " wet, rolled-up blotting paper " to that of bony hardness. The denser, firmer portions consist mainly of annular substance, whereas the softer portions represent nuclear substance. In some instances, there are small, shiny, pointed processes which extend deep into the disc.

The intravertebral prolapses of the disc and the posterior protrusions which are not infrequent findings at autopsy and which may not have given rise to symptoms during life, have been reported [4, 5] to be composed chiefly, if not exclusively, of nuclear substance. In our surgical material there was not a single instance in which annular parts of the disc were not also present. Remnants of notochordal tissue were found in numerous cases. The fœtal notochord is generally accepted as being represented only in the nucleus pulposus and it is rarely that notochordal cells may be found in the annulus fibrosus also.

From our comprehensive pathological-anatomical study we concluded that :—

(1) Posterior protrusions of the intervertebral discs causing clinical symptoms which lead to operation are composed of all parts found in the normal unprotruded intervertebral disc ; the annulus fibrosus, including its outer parts, and the nucleus pulposus, with its occasional remnants of the embryonic notochord.

(2) The tissue of the intervertebral disc is almost invariably altered in the protrusion. The most common and constant changes in it consist of structural alterations of the normal architecture of the disc.

(3) Degenerative changes also are very commonly seen. Advanced degeneration is more frequent in cases of protrusion occurring in the older age-group. Marked degeneration of the cartilage cells is much more frequent than degeneration of the fibrils.

(4) Fibrosis may occur either in the form of proliferating fibrous tissue or in close relationship with remnants of the notochord. In both cases, the fibrous tissue tends to replace the normal fibrocartilaginous structures of the protrusion.

(5) Œdema of the protruded part of the intervertebral disc is a most important and frequent finding. It may involve the annulus as well as the nucleus and is more frequent in young individuals.

(6) The œdema of the protrusion must be considered as a result of the capacity of the nucleus pulposus to swell, if the normal forces keeping it in place and shape are decreased. At the same time, it may be helped or held back by circulatory changes resulting from the displacement of the protruded part.

(7) The occurrence of œdema may result in exacerbation of the clinical symptoms. Such an exacerbation may, however, subside either spontaneously or because of conservative treatment.

(8) From this study it is not possible to draw any conclusions about the relationship of notochordal rests to the ætiology of the protrusion of intervertebral discs.

Symptomatology of Protruded Intervertebral Discs

The most characteristic and outstanding symptom of disc protrusion is pain of an intractable nature in the distribution of one or more nerve roots : that is, the pain will not disappear under the usual, previously accepted and time-honoured methods of treatment. The situation of the pain depends, of course, upon the level of protrusion. Protrusions in the cervical and thoracic regions of the spinal column give rise to symptoms more or less characteristic of extradural tumours (neoplasms) situated in those regions. The pain and other symptoms, however, ordinarily show a greater tendency to intermittency than they do in the case of neoplasms. As is well known, tumours show a definite tendency to progression, with symptoms and signs becoming gradually more marked. Protrusions in the lumbar region (and these constitute by far the majority of all protrusions) are characterized by chronic, intractable, recurring, low back and sciatic pain.

The low back pain may be centred at the lumbosacral junction, and there may be pain and tenderness over one or both sacro-iliac synchondroses. The sciatic pain is usually unilateral, although it may be bilateral with a severity that is greater in one lower extremity. The pain usually is accentuated by coughing, sneezing or straining at stool and by any other action which temporarily increases the intraspinal pressure. Night pain or pain occurring in the early hours of the morning, causing the patient to get out of bed and walk the floor or sit on a chair, is a common complaint. This type of pain was a feature of about one-fourth of our cases. Paræsthesia in the distribution of the involved nerve is likewise a common symptom. Paræsthesia has been present in about one-half of our cases. In most cases of protrusion in the lumbar region, the normal lumbar curve is obliterated. The spinous processes of the lower lumbar vertebræ may even become prominent because of a reversal of the normal lumbar lordosis. Because of spasm of the lumbar muscles, all motions of the back are limited and painful. The patient frequently walks with a distinct list to one side. A limping gait may be noticeable. In fact, an intraspinal lesion (protruded disc) is often suspected and later confirmed when the patient is asked to walk across the examining room, so that his gait can be observed. The gait is typical in cases of protruded intervertebral disc. The straight-leg raising test (Laségue's sign) is positive, as is also Kernig's test. On palpation the sciatic nerve is found to be tender, and there is usually a diminution or absence of the Achilles tendon reflex on the involved side. In a small percentage of cases there is a segmental sensory loss and muscular weakness; however, when extensive neurological signs are detected, the possibility of an intraspinal neoplasm should be more often considered.

Thus when an individual presents himself for examination with a chief complaint of low back and sciatic pain which has not responded to conservative treatment, a protruded disc in the lumbar region is the diagnosis most likely to be correct if there is a scoliosis, limitation of spinal motion, loss of lumbar lordosis, positive Laségue's and Kernig's signs, sciatic tenderness and diminished or absent Achilles tendon reflex.

Spinal Fluid

Every patient suspected of having an intraspinal lesion should undergo diagnostic lumbar puncture with the Queckenstedt test, and an examination of a suitable quantity of spinal fluid should be made. The needle should be introduced at as low a point as possible in the lumbar region of the spinal column, usually between the last lumbar and the first sacral vertebræ. It is important to introduce the needle at a point sufficiently low in the spinal canal to ensure its entry below the position of a lesion which may be present, particularly since most protruded intervertebral discs occur at the 4th and 5th lumbar interspaces [14] (fig. 1). Protruded discs in the lumbar region rarely give evidence of spinal subarachnoid block at lumbar puncture. Such a block is much more likely to be found in the presence of cervical and thoracic protrusions than it is in those of the lumbar region.
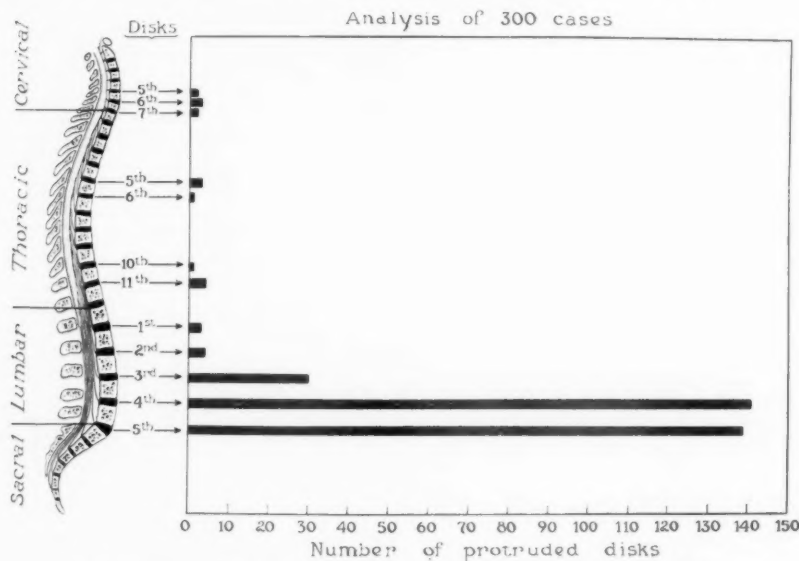
Fig. 1.—Diagram of a median section of the normal spinal column with an indication of the interspaces and the numbers of, and relative incidence in, protruded intervertebral discs which occurred in consecutive series of 300 patients subjected to laminectomy at the Mayo Clinic for protruded intervertebral discs.

Difficulties may be encountered if an attempt is made to introduce the needle into the interspace at which the protrusion has occurred. The procedure may be so painful to the patient that it will not be tolerated, or the end of the needle may strike the protrusion so that no fluid can be obtained. While searching for a means to obviate such difficulties, I discovered a procedure which I have chosen to call the " reversed Queckenstedt test " [14]. As already stated, lumbar protrusions rarely produce a subarachnoid block, hence this test should not be expected to indicate the presence of a block, but the production or exaggeration of the pain to a marked degree during performance of the test is indicative of nerve root compression. The test is simple; it consists of a combination of the ordinary diagnostic lumbar puncture with manometric recordings, and the epidural injection of a solution through the sacral hiatus. Procaine hydrochloride (1%) in 10 c.c. fractions (40 c.c.

total) is the solution employed. After a study of the hydrodynamics, 15 c.c. of cerebrospinal fluid is collected in a sterile container for careful analysis. Although the spinal fluid is tested routinely for evidence of syphilis, for total protein and globulin contents and although a cell count is made, the most important finding is that of the quantity of total protein [26]. In cases of protruded disc, as in cases of intraspinal neoplasms, an elevation of the total protein content might be expected; however, less emphasis is being placed upon this finding to-day than formerly. 34% of the specimens of spinal fluid tested in 265 of our cases had less than 40 mgm. of total protein per 100 c.c. of spinal fluid. Thus, in about one-third of the cases the total protein content is normal.

Roentgenological Examination of the Spine in Cases of Protruded Disc

Protruded intervertebral discs cannot be diagnosed by the ordinary roentgenological examination because the fibrocartilage is non-opaque to roentgen rays. The findings indicated by a narrowed interspace may be helpful in the evaluation of the positive symptoms and signs if the narrowed space occurs at a level at which the presence of an intraspinal lesion could explain the symptoms. Dr. Camp [7] in an analysis of our cases, found that of 205 cases proved at operation, 81, or 39·5%, had one or more narrowed interspaces. 21 (10·2%) of the 205 cases had more than one narrowed interspace. 62 (76%) of the 81 cases had a narrowed interspace at the site of the protrusion (fig. 2a).

Examination of the Spinal Canal by Means of a Contrast Medium

From what has been said, it is obvious that in the vast majority of cases some additional diagnostic procedure is necessary to confirm the clinical impression of the existence of a protruded disc. Even if the clinical diagnosis seems well founded and is based upon positive findings as indicated by all other tests, it is often necessary to use a contrast medium in order to determine which disc is protruded. Then, too, the possibility of the existence of multiple intraspinal lesions must constantly be borne in mind. One of my early patients was found to have an intraspinal neoplasm (meningioma) in the lower thoracic region in association with posterior protrusion of all the lumbar discs. That patient had suffered from a paraplegia resulting from spinal cord compression incident to the growth of the tumour, and a root pain secondary to one of the disc protrusions. Removal of compression of the spinal cord and nerve root resulted in cure. In an analysis of more than 200 roentgenological examinations done with radiopaque oil and made in the course of diagnosing intervertebral protrusions, Dr. Camp [7] has reported an incidence of 12% in multiple protrusions (fig. 2b). I have performed laminectomy in several cases in which all the lumbar discs were protruding into the spinal canal.

Radiopaque oil [24] (40% iodine in poppy seed oil) has been mentioned as a contrast medium useful in the examination of the spinal canal in cases of suspected protruded discs. Up to the present we have relied almost entirely upon radiopaque oil, and it has given us a much higher percentage of accurate diagnoses than has any other method. More recently we have employed air [28] as the contrast medium in some cases suspected of having an intraspinal space-taking lesion, but in our hands the accuracy of results obtained by the use of air does not compare favourably with that obtained from the use of radiopaque oil; using radiopaque oil, the clinic roentgenologists have maintained an error of less than 10% in our series of cases [7].[1]

[1] In 11 cases, in spite of the inability of the roentgenologist to detect a protruded disc upon examination of the spinal canal by means of injection of radiopaque oil, I have performed laminectomy and exposed and removed a protruded disc which was causing the patient's symptoms. The clinical histories and findings, other than those obtained by using radiopaque oil, were classic for the condition.

The diagnosis of protrusions into the spinal canal using radiopaque oil consists of the fluoroscopic and roentgenographic demonstration of persistent defects in the column, delineated by the radiopaque oil. The defects are characteristic of an extradural lesion, are usually lateral, and are opposite the intervertebral space [6].

The routine use of 5 c.c of radiopaque oil is recommended in order to detect the smaller lesions. The oil is injected by the neurosurgeon only in carefully selected cases and the roentgenological examination is performed immediately by the roentgenologist. The indiscriminate use of radiopaque oil is to be avoided and its use in the presence of an inflammatory lesion is contra-indicated.

It is my practice to inject the radiopaque oil through an ordinary needle designed for lumbar puncture, introduced into the lumbar subarachnoid space between the

FIG. 2.—(*a*) Anteroposterior roentgenogram of the lumbar spine showing hypertrophic osteitis or arthritis, involving the 4th and 5th lumbar vertebræ, with narrowing of the associated interspace. (*b*) Postero-anterior roentgenogram which disclosed a defect opposite the 3rd interspace and another opposite the 4th interspace in the column of radiopaque oil. The patient had suffered from intermittent lumbosacral backache for twenty years following a back injury when he was thrown from a horse. Removal of a protrusion of the 4th lumbar disc, resection of an associated hypertrophy of the ligamentum flavum at the same level, and resection of an hypertrophied ligamentum flavum at the 3rd interspace, resulted in relief of the patient's symptoms and signs.

spinous processes of the 3rd and 4th lumbar vertebræ. The spaces between the 4th and 5th lumbar and 5th lumbar and 1st sacral vertebræ are avoided because of the great frequency with which protrusions occur at these levels. If the needle is introduced at the site of the protrusion, severe pain may result and there is a greater chance of the radiopaque oil escaping into the epidural space. The latter occurrence will not permit of a satisfactory examination and a false positive diagnosis may be obtained. The cisternal injection of radiopaque oil is hazardous and is therefore justified only when fluid cannot be obtained from the lumbar region of the canal.

Examination of the spinal canal with air as the contrast medium is dependent upon replacement of the cerebrospinal fluid with air and the making of lateral and anteroposterior roentgenograms [28].   With the patient on a tilting X-ray table in the lateral recumbent position, a spinal puncture needle is introduced between the spinous processes of the 1st and 2nd lumbar vertebræ.   The head of the patient is then lowered to an angle of 40° by tilting the table.   The patient is held in place by means of shoulder rests.   The fluid in the caudal sac is then fractionally replaced by air injected with a Luer syringe.   Ordinarily, 30 to 50 c.c. of air will fill the lumbar sac.   A lateral roentgenogram of the lumbar spine is made, then the patient is turned on his back and stereoscopic anteroposterior films are exposed.   Air has the distinct advantage of being more or less rapidly absorbed ; however, the margin of error

FIG. 3.—(*a*) Defect in column of air within the spinal subarachnoid space at the lumbosacral interspace, caused by protrusion of the lumbosacral disc. (*b*) The same defect demonstrated on the following day by means of roentgenological examination with radiopaque oil as the contrast medium.

is much greater than it is with the use of radiopaque oil. It is our hope that someone will be able to prepare a substance that will give the same or an even greater degree of accuracy than that obtained from the use of radiopaque oil and which will yet be rapidly absorbed from the subarachnoid space (fig. 3 *a* and *b*).

Treatment of Protruded Intervertebral Disc

The curative treatment of protrusion of an intervertebral disc is the surgical removal of the fragmented and protruded portion of that disc through a laminectomy wound.[1] If the protrusion is in the cervical or thoracic portion of the spinal canal and definite evidence of spinal cord compression is at hand, the operation should not

[1] On December 1, 1938, I was able to remove successfully a unilateral protrusion after resection of the associated hypertrophied ligamentum flavum without the removal of any portion of the adjacent laminæ.   The removal of the protrusion of the 4th lumbar disc afforded the patient relief from his severe low back and sciatic pain in the left extremity.

be delayed. If the lesion occurs in the lumbar region and the only untoward symptom is mild pain, palliative measures may be employed with the hope that the symptoms will remit. Often, rest in bed will suffice to give relief from an acute mild attack of pain. If there is definite evidence of interruption of nerve pathways, then it is my feeling that surgical intervention should be undertaken without delay.

The question is often asked, especially by orthopædic surgeons, " What happened to these patients (with protruded lumbar disc) in the past, before laminectomy with removal of the protrusion became such a common practice ? " In all fairness, we must assume that some patients suffering from protruded discs must have been relieved by orthopædic measures. Also, we must admit that orthopædic treatment not infrequently failed to result in relief. We need only recall the important paper of Goldthwait to become aware of the possible danger of some measures which have been used rather freely in the treatment of low back and sciatic pain. At the Clinic we had a very unfortunate and entirely unforeseen complication arise following a fusion operation in the lumbosacral region for low back and sciatic pain. That patient suffered a paraplegia within twenty-four hours as a result of further protrusion of fragments from a lumbosacral disc. That patient was operated on at a time when our experience with protruded discs was small.

It can be assumed, I believe, that in the past some patients with protruded intervertebral discs have been relieved of their low back and sciatic pain by the operation for bone graft. The satisfactory result can be appreciated on the basis of our knowledge of the lesion itself. It is logical to assume that if a patient is kept in bed at rest for from six to eight weeks and if the interspace at which the protrusion has occurred is splinted by a graft, the protrusion may cure itself by undergoing fibrosis and contraction. Even if this method of treatment could be relied upon, there is much to be said against its general adoption. The economic factor alone is sufficient to engage interest in devising some other method of treatment. If a patient with a protruded disc is experiencing trouble sufficiently severe to warrant a two weeks' period of hospitalization, he is, in my opinion, having enough trouble to warrant a laminectomy for removal of the protruded part of the offending disc.

When the diagnosis of protruded disc is made and operation is decided upon, there remains only the question of choice of anæsthetic. The operative risk is slight (less than 0·03 of 1% in our series) and many patients have successfully undergone laminectomy who ordinarily would be considered poor risks for any major surgical procedure.

The anæsthetic usually employed is ether given by the open drop method after a preliminary hypodermic injection of 1/150 grain (0·0004 grm.) of atropine sulphate. During the hay-fever season allergic patients have been operated upon under intravenous anæsthesia (pentothal sodium) [1]. This anæsthetic likewise has been employed in treating patients having asthma and severe essential hypertension and in a few cases for patients recently recovered from an infection of the upper part of the respiratory tract. In two cases the laminectomy was performed without incident under paravertebral block anæsthesia (solution of 0·05 of 1% of procaine hydrochloride) but when elevation of the involved nerve root was attempted in order to remove the protrusion, it was necessary to anæsthetize the patient by the intravenous injection of a solution of pentothal sodium.

The operation for the less common protrusions in the cervical and thoracic regions is of necessity technically different from the operation for protrusions in the lumbar region. In the cervical region not only the situation of the protruded disc itself, but if possible, the side to which it has protruded, should be determined before operation. Whenever possible, unilateral laminectomy is the operation of choice in this region because of the normally free range of motion [3]. The laminectomy should consist in the removal of at least two laminæ on the side of protrusion so that trauma to the cord may be avoided during removal of the protrusion. The

fragments may be removed extradurally or it may be easier to remove them trans-durally, a decision which cannot always be made before exposure of the lesion. Division of the teeth of the dentate ligament here and in the thoracic region also facilitates rotation of the spinal cord and thus aids in exposure of the disc [19].

In the thoracic region, a bilateral laminectomy upon the two vertebræ adjoining the protrusion is the operation of choice. In the lumbar region, because of the struc-tural nature of the cauda equina and its consequent greater freedom of motion, the laminectomy has been modified considerably. In this operation only one spinous process or a portion of the two adjacent processes is removed. Only one pair of

FIG. 4.—Post-operative roentgenogram, demonstrating the small amount of bone which had to be resected to permit removal of a large protruded portion of the lumbosacral disc.

laminæ is removed and often only a portion of the laminæ is removed, so that not even one neural arch is interrupted (fig. 4). The articular facets are preserved in all regions. The ligamentum flavum which bridges the space between the laminæ of adjacent vertebræ has become thickened in the vast majority of cases of pro-truded disc and it must be resected before the involved nerve root can be seen. A wide resection of the hypertrophied ligamentum flavum permits the introduction of a small nerve root retractor [16] and when the œdematous nerve root is retracted toward the mid-line, the protruded portion of the disc is exposed (fig. 5 *a* and *b*). In many cases, as soon as the nerve root is withdrawn from the protrusion, the frag-ment or fragments of cartilage are seen to be lying free, so that they may be grasped easily with a bayonet forceps. In other cases, the protrusions will be seen to be confined by a capsule-like bulge formed by the stretching of the posterior longitudinal ligament, which is abnormally thin over the dome of the protrusion. The intro-duction of a pointed forceps or incision with a ureteral knife will permit escape of the fragmented cartilage. As the fragments emerge they tend to elongate and as they

elongate they exhibit a twisting motion. All fragments should be removed in order to minimize the chance of recurrence of further protrusion [17] (fig. 6).
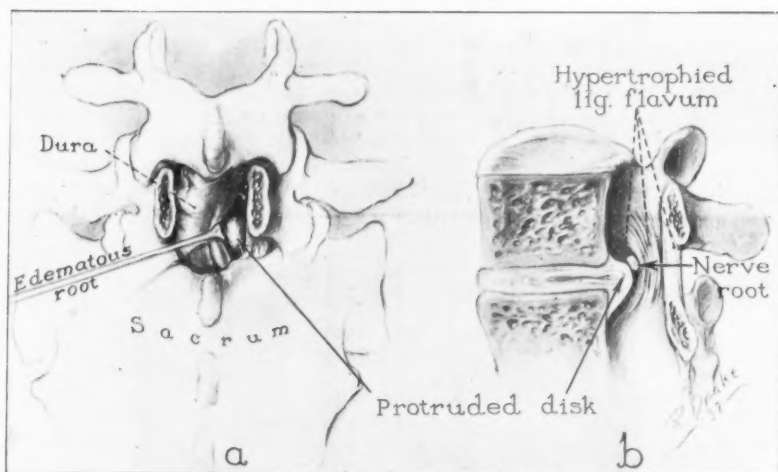
FIG. 5.—(a) Illustrating the manner in which the œdematous nerve root is retracted toward the left to expose a protrusion of the lumbosacral disc on the right. (b) A drawing executed through the sagittal plane to illustrate the manner in which the involved nerve root is compressed between the protruded portion of the disc and the overlying hypertrophied ligamentum flavum.

FIG. 6.—Photograph of the fragments of protruded intervertebral disc and the hypertrophied ligamentum flavum removed in the case illustrated in fig. 5. The dark fragment in the lower right hand corner is the hypertrophied ligament. The remaining tissue represents multiple fragments of fibrocartilage which were protruded from the disc.

The technique just described is the extradural approach usually employed. Rarely in mid-line protrusions may a transdural approach be employed. The most

troublesome factor encountered in removing disc protrusions is hæmorrhage from the extradural vessels, principally the veins. A small strip of cottonoid applied to each side of the protrusion while it is being removed will usually control the bleeding.

It is advisable to leave the meninges unopened while removing the protrusion. There are three good reasons for this : (1) There is less bleeding, because of the hydrostatic effect of the cerebrospinal fluid in maintaining approximation of the dural and epidural tissues ; (2) the already œdematous and vulnerable nerve root can be retracted with less chance of further injury if it is buffered by the cerebrospinal fluid ; and (3) if an opening should be made unexpectedly into an inflammatory lesion, there will be a minimum of danger of meningitis.

When the protrusion has been removed, the meninges are opened for the removal of the radiopaque oil, if it has been employed in the diagnosis of the lesion. If air has been used or if the patient has been operated on without the use of contrast medium, the meninges are left intact and the wound is closed. Occasionally, it is necessary to leave a short strip of plain one-inch gauze in position extradurally to control venous oozing. If gauze is used it should be left in place for seventy-two hours. A solution of pentothal sodium injected intravenously permits painless removal of the gauze while the patient is in bed.

It is my feeling that the placing of a bone graft at the time of laminectomy for protruded disc is rarely necessary or even justified. In more than 300 laminectomies performed for correction of protruded intervertebral disc, bone grafting has been done only seven times. In these seven instances the operation was combined with laminectomy because of opinions formulated after consultation between the neuro-surgeon and orthopædist, and also because either the patient had an obviously weak back prior to laminectomy or the observations at laminectomy seemed inadequate to explain all the symptoms.

Post-operative Care

The development of the method of post-operative care for patients who have undergone laminectomy for the removal of a protruded disc is interesting.

I have felt from the outset that the operation for bone graft or fusion was not only not indicated in cases in which a protrusion of the disc with encroachment on a nerve root or the spinal cord was demonstrated at the time of laminectomy, but that it would of necessity increase the operative risk, the danger of post-operative complications and necessitate a prolonged hospitalization, a severe drain on the patient's finances and a prolonged period of convalescence after leaving the hospital. Our results fully justify this contention.

Since the day Sir Victor Horsley first successfully removed a tumour of the spinal cord, it has not been considered necessary or wise to conclude the laminectomy and removal of a tumour with a bone graft.

Although it is just as essential in most cases to remove the protruded portion of the disc as it is to remove an intraspinal meningioma (a meningioma is of course a neoplasm and as such differs from a disc protrusion, which may enlarge but not by actual neoplasia), the entire intervertebral disc is never removed. We believe that removal of the protruded portion of the disc does not weaken the back (see section on technique of removal of protruded discs) and that therefore no additional support is necessary.

With my early cases the post-operative care varied widely from what it is at present. The early cases, of course, were subjected to a much longer laminectomy than the more recent ones, but from the outset it has been my practice to preserve the articular facets. In the early series it was customary to remove at least two spinous processes and two and often three pairs of laminæ. The patients were placed in bed on rolled pillows and were not allowed to move themselves until a

period of from twelve to fourteen days following operation had passed. They were turned by the nursing staff every four hours and were never allowed to lie on their backs. Many of these patients were very uncomfortable, required relatively large amounts of hypnotics, and looked forward with keen anticipation to the turning time. Many were unable to void, so that intermittent or continuous drainage of the urinary bladder by catheter was necessary. From my orthopædic training I learned that people with sore backs often felt much better if they lay on a hard, non-yielding bed. This helped to a certain extent. Use of rolled pillows was gradually discontinued. Beginning, first, at about the eighth or tenth post-operative day, the patients were allowed to turn themselves in bed. This period was gradually shortened until at present the patients are encouraged to turn about in bed, to lie on their abdomens and to exercise their legs and arms. This practice has resulted in less post-operative discomfort, has tremendously simplified the nursing problem, and has had a profound stimulating effect upon the patient's morale. Most patients now leave the hospital on the tenth to twelfth post-operative day. When they are dismissed from the hospital their general physical condition is better and the convalescence is shortened.

Since many patients are unable to void lying in bed, particularly after the cauda equina has been manipulated, as is necessary in the removal of some lumbar protrusions, the problem of catheterization and infection of the urinary tract arises. Earlier, we employed intermittent catheterization for two or three days for those unable to void. If voluntary urination did not then occur we placed an inlying urethral catheter for continuous drainage. As a prophylactic method against infection we used irrigations of the bladder with boric acid solution twice daily and administered methenamine and ammonium chloride by mouth. In spite of these measures we occasionally encountered chills and fever with malaise and pyuria caused by infection of the bladder. Also, the ingestion of ammonium chloride is likely to produce gastric distress, which is a much undesired complication.

More recently we have been allowing the male patients unable to void in bed to stand up beside the bed and use the urinal the morning following operation. The women are taken to the bathroom. One very intelligent woman told me that her back felt sore after sitting on the stool. I suggested that she remain in bed and be catheterized, whereupon she replied that the soreness in the back did not cause as much discomfort as the passage of the catheter. She continued to use the bathroom, to which, five days after operation, she was going unattended. Ten days after her laminectomy she was making her post-operative calls at the office entirely free of her previously intractable sciatic pain of several years' duration.

The early cases frequently were fitted at our request by the orthopædic surgeons with belts and corsets, but this measure was soon discontinued as our experience accumulated. To-day the patients are dismissed without our placing even a gauze dressing over the wound. They are advised to refrain from any heavy lifting or straining for a period of three months after dismissal. At the expiration of this time, they are not only permitted but are encouraged to resume their former activities. If a patient happens to be a day labourer he is advised to return gradually to his heavy duties.

Results of Operation for Protruded Discs

There has been only one death in the hospital in more than 300 laminectomies performed for protruded intervertebral disc. That death occurred in the first 100 cases reported in the *Journal of the American Medical Association* [20], and was caused by a combination of contamination of the wound and bronchopneumonia.

The removal of a classic protrusion of a disc whose displacement has resulted in compression of the spinal cord or a nerve root usually results in complete relief of the patient's symptoms. If severe damage has been caused by the protrusion,

residual symptoms and signs may persist, just as such symptoms and signs persist after the surgical removal of tumours of the spinal cord. We have come to recognize certain atypical or nonclassic protrusions, the surgical treatment of which does not produce the same excellent results as are obtained from the surgical treatment of typical protrusions. There is a type of disc abnormality which results in a posterior bulge with encroachment upon the spinal canal and its contents. The bulging occurs most often in the mid-line and is best illustrated by the cases in which a mass of tissue projects posteriorly into the spinal canal from each lumbar disc. This lesion differs markedly from the classic single protrusion and often the surgical treatment of it consists in an operation for relief of compression rather than removal of the projecting cartilage. Although I have had three such patients who obtained complete relief from their nerve root pain following an operation for decompression, there are one or two others who still have residual back pain and are unable to do hard manual labour.

Occasionally, such a lesion will be encountered in the thoracic region of the spinal column. In the thoracic region, however, we have not seen the multiple type of lesion. This mass of tissue is usually situated in the mid-line and is bony hard. Palpation of the mass with a forceps will distinguish it from the characteristically resilient mass of the protrusion usually encountered. Because of its relationship to the cord and the difficulty which it presents in removal, it has seemed best thoroughly to decompress the cord at that level and to divide the dentate ligament bilaterally in order to permit the spinal cord to move away from the mass and to avoid compression. Such an operation has resulted in relief of paraplegia in a man aged 73. If such a lesion is encountered at only one interspace in the lumbar region, it is removed with a rongeur.

One of the most striking things in medicine is to be seen in the wards the day following the removal of a protruded disc when one observes that a pinched facial expression due to pain has been replaced with a smile and the patient volunteers that all his pain has disappeared since operation. Nothing short of the relief obtained from division of the sensory root of the gasserian ganglion in cases of trigeminal neuralgia compares with it. All patients are not immediately relieved. Some continue to have slight distress for several days. This probably is related in some way to the amount of injury which has been caused by the protrusion.

Most of our patients have been operated upon too recently for us to judge accurately what the late result will be. We know, however, that patients who were operated on as long ago as 1922 have since remained well.

Summary

Intraspinal protrusion of intervertebral discs is a definite pathological entity. It accounts for many cases of hitherto unexplained intractable pain and especially that pain occurring in the low back and sciatic distribution.

There is a fairly definite clinical symptom-complex which in many cases will permit an accurate diagnosis without the use of a contrast medium in the spinal canal. However, at present it is deemed advisable to employ a contrast medium in the majority of cases.

When the diagnosis of protruded intervertebral disc has been made, laminectomy with removal of the protruded portion of the disc should be performed, provided the patient is in sufficient distress to warrant a period of two weeks' hospitalization.

The results of this treatment in more than 300 cases justify the method.

REFERENCES

1 ADAMS, R. C., *Canad. M.A.J.*, 1938, **38**, 330.
2 ADSON, A. W., *Northwest Med.*, 1925, **24**, 309.
3 ADSON, A. W., and GHORMLEY, R. K., *Proc. Staff Meet., Mayo Clin.*, 1933, **8**, 297.
4 ANDRAE, R., *Beitr. z. path. Anat. u. z. allg. Path.*, 1929, **82**, 464.

5 BEADLE, O. A., " The intervertebral discs ; observations on their normal and morbid anatomy in relation to certain spinal deformities ", Spec. Rep. Ser. Med. Res. Coun., No. 161, 1931.

6 CAMP, J. D., *Proc. Staff Meet., Mayo Clin.*, 1937, **12**, 373.

7 CAMP, J. D., and ADDINGTON, E. A., " Intraspinal lesions associated with low back and sciatic pain and their localization by means of lipiodol within the subarachnoid space ". *Radiology.* (In press.)

8 DANDY, W. E., *Arch. Surg.*, 1929, **19**, 660.

9 DEUCHER, W. G., and LOVE, J. G., *Schweiz. Arch. f. Neurol. u. Psychiat.*, 1939, **43**, 8.

10 CAPENER, N., *Proc. Roy. Soc. Med.*, 1937, **30**, 1262 (Sect. Orthop., 54).

11 GOLDTHWAIT, J. E., *Boston M. & S. J.*, 1911, **164**, 365.

12 HENDERSON, M. S., *Proc. Staff Meet., Mayo Clin.*, 1939, **14**, 233.

13 HORSLEY, VICTOR, and GOWERS, W. R., *Med.-Chir. Tr., London*, 1888, **11**, 377.

14 LOVE, J. G., *Proc. Staff Meet., Mayo Clinic*, 1936, **11**, 529.

15 Id., *ibid.*, 1937, **12**, 369.

16 Id., *ibid.*, 1937, **12**, 393.

17 Id., *ibid.*, 1938, **13**, 404.

18 Id., *Minnesota Med.*, 1938, **21**, 832.

19 LOVE, J. G., and CAMP, J. D., *J. Bone and Joint Surg.*, 1937, **19**, 776.

20 LOVE, J. G., and WALSH, M. N., *J.A.M.A.*, 1938, **111**, 396.

21 LOVE, J. G., ADSON, A. W., and CRAIG, W. McK., *Journal-Lancet*, 1938, **58**, 479.

22 MIDDLETON, G. S., and TEACHER, J. H., *Glasgow M. J.*, 1911, **76**, 1.

23 MIXTER, W. J., and BARR, J. S., *New England J. Med.*, 1934, **211**, 210.

24 SICARD, J. A., and FORESTIER, J., " Diagnostic et thérapeutique par le lipiodol clinique et radiologie ". Paris, 1928.

25 STOOKEY, BYRON, *Arch. Neurol. & Psychiat.*, 1928, **20**, 275.

26 TODD, J. C., and SANFORD, A. H., " Clinical Diagnosis by Laboratory Methods ; a Working Manual of Clinical Pathology ". Philadelphia, 1931.

27 VIRCHOW, R. L. K., " Untersuchungen über die Entwickelung des Schädelgrundes im gesunden und krankhaften Zustande und über den Einfluss derselben auf Schädelform, Gesichtsbildung und Gehirnbau ". Berlin, 1857.

28 YOUNG, B. R., and SCOTT, MICHAEL, *Am. J. Roentgenol.*, 1938, **39**, 187.

Dr. C. P. Symonds : Practically speaking, the nervous symptoms which may result from prolapse of an intervertebral disc divide themselves into two groups. One is that of compression of the spinal cord or cauda equina, the other is that of intractable sciatica. At one point—that of the cauda equina—there is an obvious overlap.

Of the first group we have had some experience. I have, for purposes of this discussion, looked through the records of 22 cases in each of which the prolapsed disc has been removed at operation and the histological diagnosis made by Dr. Greenfield. Seven of these patients have been under my own care. For permission to study the others I am indebted to my colleagues at the National Hospital.

There were fifteen instances of compression of the spinal cord in this series and seven of the cauda equina. Among the spinal cord cases the compression was at the cervical level in eight instances, the dorsal level in six, and the lumbosacral level in one. These observations as to the frequency of prolapsed discs at different levels correspond closely with those published by the earlier writers on the subject.[1]

In reviewing the material provided by these 22 cases I have asked myself, in the light of present knowledge, what evidence is to be found in clinical history or examination, X-rays, or examination of spinal fluid, which might have suggested the true pathological diagnosis before operation.

Clinical history.—In one patient only the first symptom developed directly after injury. This was a man of 31 who, five minutes after lifting a heavy weight, had stabbing pain in the right shoulder and, in the course of the next eight weeks,

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[1] This was before Mixter and Ayer drew attention to the frequency with which prolapse at the lumbar or lumbosacral vertebral levels might produce lower back pain or intractable sciatica as the only symptom. Including these cases they found prolapse causing symptoms at this level nearly three times as frequent as at the cervical level.

developed progressive symptoms of compression from prolapse of the disc between the 5th and 6th cervical vertebræ.

In four cases there was a history of old injury, the interval ranging from 7 to 35 years, but without symptoms at the time to suggest any damage to the vertebral column.

In one of the cauda equina cases the first symptom, pain in the lower back, appeared immediately after childbirth.

Seven of the 15 patients with spinal cord compression complained of root pains or paræsthesiæ which were provoked or aggravated by coughing or movement of the spine. It is well recognized that such symptoms may occur in patients with extra- or intra-medullary tumours, but the proportion of cases in which they appeared in this series is perhaps significant.

In one of the cervical cases, the first complaint was of numbness and weakness of the right hand lasting for four days, with an interval of seven months before these symptoms recurred and subsequently progressed. This is the only case in the present series with the story of remission which Elsberg has considered an important diagnostic point.

Four of the seven patients with compression of the cauda equina complained of pain in the lower back as their first symptom, and in these, as in the others with pains of root distribution, there was generally a relation of the pains to effort and posture. This, however, is a clinical story which is common in patients with cauda equina tumours.

I have seen, for example, a woman who for three years had complained of pain in the lower back, increased on effort and related to posture. At first there were periods of freedom. Later the back pain was associated with a right-sided sciatica which ended in recovery. When I saw her she had developed pain of left sciatic distribution, but her chief complaint still was of pain in the back. I could find no signs of any nervous lesion, but lumbar puncture showed a complete block with 760 mgm. protein, and she proved to have a large neurofibroma at the level of the 3rd lumbar vertebra.

My analysis, therefore, confirms the view expressed by others that, as far as the clinical history is concerned, there is no sure means of distinguishing between compression by prolapsed disc and compression by a tumour, save in the exceptional case in which the symptoms develop rapidly after injury. The results of *clinical examination* are equally indecisive. Of the 15 patients with compression of the spinal cord, seven showed bilateral motor and sensory loss of symmetrical distribution. The others showed almost every variety of the clinical picture associated with compression by tumour.

Elsberg has emphasized relative sparing of those forms of sensation carried by the posterior columns as a diagnostic point of importance. Hawk, on the other hand, found signs of posterior column defect in all his 10 cases.

In the present series, seven of the 15 patients showed posterior column defect. These were mostly cases in which the compression had reached a severe degree. In the early stages the picture of spastic weakness on one side of the body and loss of sensation to pain and temperature on the other without posterior column defect on either side was common, but in one of the cervical cases an ipsilateral defect of postural and vibration sense in the hand was one of the earliest findings, and in another there was a complete Brown-Séquard picture including posterior column loss on the side of the lesion. We are accustomed to these variations in cases of spinal tumour and have learned to be cautious in our attempts to deduce from the clinical signs the exact point of its circumference at which the cord is compressed. On the whole, however, the sequence of events in these cases of prolapsed disc is that which we should expect from anterior compression. The one case in the series in which the lumbosacral enlargement was compressed by a prolapsed disc between the last dorsal and first lumbar vertebræ provided the best example of this clinical picture. There

was a severe degree of paraplegia with wasting of the anterior thigh muscles, absent left knee-jerk, brisk ankle-jerks, extensor plantar responses, and loss of sphincter control, with only a patchy hypalgesia of the lower limbs.

In the seven patients with discs compressing the cauda equina the clinical picture was that usually found in tumours at this level, varying only in the degree of motor, sensory, and reflex loss. In one case the symptoms were purely subjective. The history was that of intermittent pain in the lower back for three years and for three months pain in both buttocks radiating down the back of the thighs. Following a manipulation, difficulty in micturition had been experienced for three weeks. There were no abnormal physical signs but the spinal fluid contained 260 mgm. of protein and a prolapsed disc was removed from between the 4th and 5th lumbar vertebræ.

In one other patient of the cauda equina group numbness of the saddle area and impairment of sphincter control immediately followed manipulation.

In four cases, all in the dorsal region, the X-ray examination showed calcification in the prolapsed disc making the pre-operative diagnosis certain.

Queckenstedt's test was performed in 19 cases. Six showed a complete block ; 10 a partial block ; and three no block. The cases in which there was no block were all in the cauda equina group, the puncture being above the level of compression. In each of these cases, however, the protein content was raised.

The protein content of the fluid was estimated in 20 cases. In two only was it within normal limits. Both cases were in the cervical group ; both showed partial block with Queckenstedt's test, and in both there was subsequently shown an arrest of lipiodol at the appropriate level. This is in accord with our experience of compression at the cervical level from other causes, i.e. the protein content may be low in relation to the evidence of block shown by manometry and lipiodol injection.

In the other cases of the series the protein content varied from 90 to 4,000 mgm., the highest figures being found in the cauda equina group when fluid was obtained from below the level of compression.

Lipiodol was injected in eight cases and in each instance was arrested at the appropriate level. In the remainder, the clinical signs provided sufficient evidence of localization.

The evidence obtained from lumbar puncture and lipiodol, therefore, is such as we are accustomed to find in cases of compression of the spinal cord or cauda equina by tumour.

From my review of this material I must conclude that the clinical evidence in each case suggested compression, but in only one instance, that of the patient whose first symptoms occurred after lifting a heavy weight, was there anything to suggest a prolapsed disc as the cause. In four cases the X-ray provided the pathological diagnosis by revealing a calcified nodule arising from the disc. In the remainder, after full investigation, the cause of compression remained doubtful and might as well have been tumour as disc.

We must not, of course, lose sight of the possibility that in the routine investigation of our patients suspected of compression lesions we have been allowing some of those with prolapsed intervertebral discs to slip through. This is the impression conveyed by Elsberg who, when he began to look for them carefully, found prolapsed discs much commoner than he had supposed. He concluded that of all causes of compression the prolapsed disc is most apt to cause symptoms without evidence of subarachnoid block. If we add to this conclusion the observation that the symptoms may sometimes recede or may remain stationary over a long period, we must admit that the differential diagnosis from disseminated sclerosis may be a matter of difficulty. Many patients with disseminated sclerosis, as we know, begin with a gradually progressive spastic weakness of the lower limbs, which may remit, or remain stationary for years, before other evidence of the disease appears. It is part of our daily routine to

distinguish these patients from those whose symptoms are due to compression by spinal tumour. If the routine tests for subarachnoid block are negative and the subsequent course of the disease is non-progressive we are ready to accept the diagnosis of disseminated sclerosis. May some of these patients in fact have prolapsed discs ? Ought we to ask for an exploratory laminectomy more often in this group with the possibility of prolapsed disc in mind even though evidence of subarachnoid block remains absent ? These are questions which I should like to hear discussed by other neurologists present.

In two of the seven cases of cauda equina compression which I have reviewed, the early story was that of a persistent sciatica—that is to say, pain in the posterior thigh and postero-lateral calf. In one case these symptoms persisted for three years and in the other for four and a half years before numbness of the perinæum and impaired sphincter control provided indubitable evidence of a central lesion. It was not until these symptoms developed that the patient was sent for a neurological opinion. But it may be safely assumed that if the neurologist had been consulted sooner the suspicion of cauda equina tumour would have entered his mind, as it must always do in a case of sciatica persisting as long as a year. This suspicion would at any rate have led to a lumbar puncture and if the protein content of the spinal fluid were found grossly raised this would have been followed by lipiodol injection. Whether these methods of investigation as hitherto employed and interpreted by the neurologist would at this hypothetical earlier stage have led to a true diagnosis is open to discussion.

I have had as yet no personal experience of the diagnosis of prolapsed disc in the stage when it causes no symptoms other than those of a unilateral sciatica. Since reading Mixter and Ayer's paper three years ago I have used the new radiological method described by them in half a dozen cases with only one positive finding—a case of unilateral diffuse neurofibromatosis involving at the time a single root.

It is at once evident that the American surgeons and neurologists, represented here this evening by Dr. Love, have made a most important contribution to the advance of knowledge. Their work has thrown light into a dark corner of clinical medicine. They have given us a clear view of the pathology of one group of the sciaticas. The importance of this may be measured by our past ignorance of the subject. As Barr has justly remarked, a search into the literature of sciatica reveals a plethora of cures but a sad dearth of knowledge of what is being cured.

This brings me to my first point. Whenever we hear of a plethora of cures for a disease we may be pretty certain that it is a disease which tends to get well by itself, and that this is true of sciatica no one would dispute. It is a truth which was conveyed to me at an impressionable moment by one of the wisest of all my clinical teachers, Sir William Hale-White, when I was his house physician. We were going round together on the first day of my appointment and the first patient we came to was a man with sciatica. As we passed on to the next bed Sir William remarked to me " you will find that the best time to be called to a case of sciatica is when the patient is beginning to get well ".

Now it surely is true that the great majority of patients with sciatica—we might say loosely ninety-nine out of a hundred—do get well in the end whatever is done or left undone : more rapidly I think with rest and warmth in the early stages and massage and exercises later, than if they are subjected to manipulative treatment or the ordeal of frequent journeys to a clinic for some form of radiant heat. Now the question which naturally arises out of the present discussion is how many patients whose sciatica has been due to a prolapsed disc—of course unrecognized—have in the past recovered with rest alone ?

When I consider the clinical story which is regarded by some writers as characteristic of prolapsed disc, it sounds to me very familiar. It is the story of one or more attacks of acute lumbago—a sudden immobilizing pain in the lower back when rising

from the stooping posture, with recovery after a few days rest, and finally a similar attack which is followed immediately or after an interval by the development of sciatica. This is a story which we have heard from scores of patients whom we have seen recover with rest and warmth alone.

Nor, as far as I can judge, is there anything to be found in the clinical examination of those patients whose sciatica has ultimately been proved due to a prolapsed disc, which is different from the signs ordinarily to be observed in patients who get well without surgical interference.

There remains the question of the protein content in the spinal fluid. An increase of protein has been taken by writers on the subject of prolapsed disc as a definite indication for massive lipiodol injection. I am not clear in what proportion of the cases with increased protein the lipiodol has revealed a filling defect and a prolapsed disc has been found, or what irritant effects the lipiodol may have caused in negative cases—these are questions upon which I should like information. The fact which has interested me is that in most of the cases of unilateral sciatica proved to be due to prolapsed disc, the increase of protein has been relatively small. Mixter and Ayer found it between 56 mgm. and 91 mgm. in fluid obtained from above the lesion, and Barr found it in 85% of his cases between 40 mgm. and 100 mgm. These are figures which in neurological practice we have seen so often in cases of sciatica without any clinical evidence of cauda equina lesion, and ending in complete recovery when treated by rest, that we have accustomed ourselves to the view that in any case of long-standing sciatica the protein may be raised to this extent. It may well be that we have been blind for want of looking, and that if we had injected 5 c.c. of lipiodol into all these patients with a rise of protein, we should have seen prolapsed discs in many of them—perhaps in all. If so our blindness fortunately did not prevent recovery.

I am led from these considerations to suppose that if prolapsed intervertebral disc is anything but a very rare cause of sciatica, it is a lesion which is in most cases capable of spontaneous repair.

It may well be some time before we are able to make the best practical use of this new contribution to our knowledge. At present there are questions to be answered. The following are in my own mind.

(1) In what proportion of patients with unilateral sciatica and a protein content in the spinal fluid between 40 and 100 mgm. can a prolapsed disc be demonstrated by the new lipiodol technique ?

(2) What ill-effects, if any, may result from the injection of 5 c.c. of lipiodol in a negative case ?

(3) If some of the patients with raised protein prove not to have prolapsed discs what clinical features are there in the positive group which are distinctive ? In short what are the clinical grounds which should warrant the injection of 5 c.c. of lipiodol into the thecal sac ?

(4) Of the patients with radiological proof of prolapsed disc as the cause of their sciatica, what proportion may recover when treated by rest ? If there are patients who do recover with such treatment, is the duration of disability longer or shorter than in patients treated by operation ? In patients who have recovered with rest alone is the liability to recurrence greater or less than in those treated by operation ?

REFERENCES

BARR, J. S. (1938), *Brit. M. J.* (ii), 1247.
ELSBERG, C. A. (1931), *Bull. Neurol. Inst. New York*, 1, 350.
GLORIEUX, P., " La Hernie Postérieure du Ménisque Intervertébral ". Paris, 1937.
HAWK, W. A. (1936), *Brain*, 59, 204.
MIXTER, W. J., and AYER, J. B. (1935), *New England J. Med.*, 213, 385.

Dr. Campbell Golding : It has been established that the procedure of the intrathecal injection of lipiodol has reached a stage when a comparatively simple operation may result in a picture which can be interpreted without great experience, and this radiogram will give precise information about a condition which must have been wrongly diagnosed in the past.

I regret to say that in the early days of this examination we only had four positive findings in the first 29 patients examined. Since that time, however, our percentage of successes has increased.

It would be interesting to know what the percentage of successes has been in other clinics, and whether many cases with negative X-ray findings have been found, at operation, to have protrusions.

One of the patients seen by Mr. Bankart recently, was a comparatively young adult who felt something give way in his back while lifting a heavy weight. This was followed by bilateral sciatic pain, and he was found to have a raised protein content in the cerebrospinal fluid. We carried out a very careful search for a prolapsed disc, but could not find one.

After our earlier efforts, I felt that this was an operation which might well be reserved for the out-patient, but was hardly suitable for one's friends, especially as there were many vague references to the calamities which might follow the injection of lipiodol. I heard a surgeon say quite recently, " Heaven help the unsuspecting individual who wanders into orthopædic out-patients these days, and admits having sciatica ".

I think that this meeting would serve a useful purpose if it could be established whether or not any real injury has ever followed these injections.

Radiological Technique

The one that we have found to be most satisfactory is to commence with the patient standing on a foot-rest at the end of a motor-driven couch. In this position the lipiodol collects in the region of the 2nd sacral segment. The table is then lowered, and the path of the oil is watched on the screen.

This table can be tilted down to about 30° below the horizontal, and the lumbar spine can be examined. To obtain a greater tilt, the position of the patient is changed so that the head is lowered when the table is raised again.

A most useful accessory is the attachment used for taking serial views of the duodenal cap. By using this screening apparatus, four serial views of any area, or one exposure of each of four disc spaces, can be obtained on the same film ; it also has the advantage that the films can be taken very quickly, that is, before the lipiodol moves beyond the area required.

We have found that the two most reliable positions are : (*a*) The plain anteroposterior, and (*b*) the oblique position in which the patient is tilted so that the side of the lesion is raised. For some reason, it appears that this shows the lesion better than the opposite oblique.

The lateral view has been found to be misleading, as there is a tendency for some lipiodol on the normal side to be thrown over the protrusion.

It has also been noted that the normal disc can indent the lipiodol to a marked extent in the mid-dorsal region in kyphosis, particularly in adolescent kyphosis.

Abnormal Appearances

Within the last few months, there have been three patients with a peculiar defect in the column of lipiodol. The appearance on the film resembles a string of sausages, and we have been most anxious to discover the significance of this finding.

A similar appearance has been described in the literature as due to multiple

herniations, arachnoiditis, arachnoiditis plus multiple herniations, and von Recklinghausen's disease.

These filling defects were most constant, and caused considerable delay in the passage of the lipiodol.   Two of these patients refused operation.   The third was to have been operated on some months ago.   In this case, the defect was present in the lower dorsal spine.   The operation was delayed by factors which had no bearing on the patient, and she subsequently improved to such an extent that the operation was no longer justified.   She was a young girl, suffering from spastic weakness of both legs, and she is now walking very well.

Relative Use in Different Regions

It has often appeared to me that the radiographic examination of the dorsal and cervical regions is much less satisfactory than that of the lumbar spine.   The column of lipiodol tends to become thin in this region, and possibly some protrusions are being overlooked.   Neither are the illustrations of these lesions which appear in the literature very impressive.

Patients are continually being sent for X-ray examination for ? cervical rib, or for some examination to determine the cause of pain in the upper limbs.   One cannot help wondering whether protrusions are not being missed in the region of the cervical enlargement of the cord.   In this connexion it should be remembered that Andrae's post-mortem findings showed that the lumbar region was not the most frequent site of protrusions of the disc.

Dr. J. MacDonald Holmes: My personal experience of these lesions is limited to two cases.   The first was up to that time the only one in which I had injected a large amount of iodized oil into the theca in an attempt to demonstrate a disc protrusion, but I have since reviewed 37 cases of chronic sciatica seen during the past year or so, of which I selected four for iodized oil injection, mainly because there was a history of injury and a poor response to treatment.   The special radiography of these four cases failed to reveal any disc lesion.

My first case was a miner, aged 58, who complained of left sciatic pain of seven months' duration.   There was much wasting of the left thigh and calf, an absent left ankle-jerk, and Lasègue's sign was present.   In addition there was some slight sensory impairment in the back of the left leg in the 1st and 2nd sacral distribution. He gave a history of injury to his back twelve years ago, when he was seized with a sudden severe pain in the lower lumbar region when lifting a heavy tub in the mine. He was off work for about a month owing to pain in the back, but had no further trouble until the onset of the sciatica seven months ago.   Antero-posterior and lateral radiograms taken in the prone position after the injection of 6 c.c. of iodized oil (non-viscous " neohydriol ") showed a definite filling defect opposite the 5th lumbar intervertebral disc (*see* fig. 1).

My surgical colleague Mr. B. R. Sworn performed a laminectomy on February 14, 1939, and removed a loose piece of fibrocartilage from the position in which the filling defect is visible in the radiograms, abutting against the left 5th lumbar nerve root.   In view of what has been said about the innocuousness of iodized oil when allowed to remain in the theca, it is interesting to note that this patient developed a severe meningeal reaction twenty-four hours after operation, with headache, neck rigidity and pyrexia. Cisternal puncture revealed a turbid cerebrospinal fluid containing 4,000 polymorph cells per c.mm., but it was sterile on culture.   I attribute these meningeal symptoms to irritation from the iodized oil, which, owing to the position of the patient on the operating table and later tilting of the foot of the bed, had trickled upwards to the cervical region and the posterior fossa.   Apart from this meningeal reaction recovery was uneventful, and the patient is now entirely free from pain, and is able to walk about in a normal way.

The cerebrospinal fluid of this case before operation contained 55 mgm.% of protein, but was otherwise normal. It was taken from above the level of the lesion, and there were no manometric changes.

My second patient was a woman aged 28 who had had three Cæsarian sections owing to a severe scarring of the vulva and abdominal wall as a result of burns in childhood. The last Cæsarian operation was done under spinal anæsthesia two years ago, and since that time the patient has had severe intermittent bilateral sciatic pain, brought on particularly by sudden movements such as stooping or turning over in bed, and also by coughing. The only physical signs were slight peri-anal sensory

FIG. 1.—Anteroposterior view after injection of 6 c.c. neohydriol
(in prone position).

impairment and Laségue's sign. Radiograms taken in the prone position after the injection of 5 c.c. of neohydriol showed a constriction of the lumbar theca at the level of the 4th lumbar disc (*see* fig. 2).

The protein content of the cerebrospinal fluid was 80 mgm.%, but it was otherwise normal.

Mr. Sworn performed a laminectomy on this case on March 29, 1939, and found a much thickened ligamentum flavum opposite the 4th lumbar disc, which was constricting the theca. The thickened portion of ligament was excised, and it was found that there was a protrusion of the posterior common ligament into the spinal canal at the same level, presumably due to herniation of the disc, but as the ligament was not ruptured, this protrusion was left undisturbed. It was considered that the theca was sufficiently freed from compression by the laminectomy

Fig. 2.—Anteroposterior view after injection of 5 c.c. neohydriol
(in prone position).

and excision of the thickened ligamentum flavum. Recovery has been uneventful, and the patient is now entirely free from pain. It is almost certain that the disc lesion in this case was due to the lumbar puncture used for the spinal anæsthetic.

Mr. Bankart said that he had operated upon four cases of prolapsed intervertebral disc. In two cases the disc between L.V.4–5 was affected, and in two the lumbosacral disc was prolapsed. Three of the four cases gave a definite history of sudden strain immediately preceding the onset of symptoms. In only one case was the protein content of the cerebrospinal fluid raised. In one case there was a uniform projection of the disc right across the anterior wall of the spinal canal, and the lipiodol was held up immediately above the projection. This disc was not removed and the patient was cured by the laminectomy. In each of the other three cases a filling defect was seen on examination with lipiodol, and a localized protrusion of the disc was found and removed. All the patients made a rapid and complete recovery.

Mr. Robert Ollerenshaw (President of Orthopædic Section) : I was glad to find that both Dr. Love and Dr. Symonds referred to the value of conservative treatment in these cases. The very large number of cases at the Mayo clinic, however, in which definitely protruded discs were found, must make us all realize that a good many of our " chronic back " cases are probably suffering from this condition and that we must make a complete and very careful search amongst them. The large proportion of positive findings, in which there was a clear history of a

sudden pain in the back during overstrain is very striking. Obviously the cases we, in the orthopædic departments, must suspect are those which have

(1) A history of sudden back-pain whilst straining.

(2) Definite localized back-pain, with radiation down the back of the thigh to the leg and foot (root pain).

(3) Diminished reflexes on the affected side.

If these findings are present a cerebrospinal fluid examination should be made and, if there is evidence, by Pandy's test, of a protein content of more than 40 mgm. to the 100 c.c., a lipiodol injection should be regarded as fully justified and, in the presence of a filling defect, a laminectomy should be undertaken.

Dr. J. Grafton Love (in reply): I have been glad to hear of the excellent results which are being obtained in England when a protruded disc is found to be the cause of intractable sciatic pain and backache and the proper treatment—laminectomy—is carried out. Again I should like to emphasize the fact that we in America lean toward conservatism in the treatment of backache and " sciatica ". Every patient should have a thorough trial of conservative orthopædic treatment—unless there is obvious evidence of spinal cord or nerve root compression—before lipiodol is employed to exclude a protrusion of an intervertebral disc. If conservative treatment is ineffectual and the symptoms and signs which I have already enumerated are at hand, examination of the spinal subarachnoid space with lipiodol is justified.

The medico-legal cases are the most difficult. Since it is generally accepted that disc protrusions are traumatic the compensation factor may cloud the issue considerably. Not only is the question of liability important in the diagnosis of protruded intervertebral discs but also in the evaluation of the results of therapy. No matter how pleasant a convalescence the patient may have, he may volunteer that he has not been completely relieved. This is likely to occur if the patient feels that he is entitled to compensation or insurance and is not able to obtain it. There are also individuals who constitutionally withstand the trials of life poorly, and they are prone to suffer with minor complaints after being relieved of a more or less serious condition. Of course, these same difficulties are encountered in evaluating the results of therapy in other conditions, but the patient with backache and " sciatica " seems to present a particularly difficult problem.

Our results with laminectomy and the removal of the fragmented and protruded portion of the intervertebral disc causing spinal cord or nerve root pressure have been most gratifying, and it is my feeling that this will become generally recognized as the treatment of choice. Adson, Craig and I have performed laminectomy 417 times for disc protrusions with one death. This should not, however, be taken to indicate that laminectomy is a minor procedure.